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POWER

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NEW YORK, APRIL 16, 1912.

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Outline of Topics, 50.
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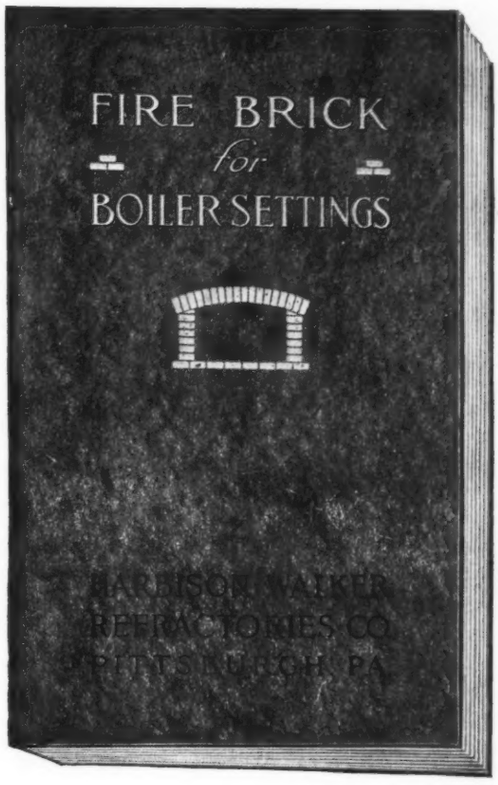

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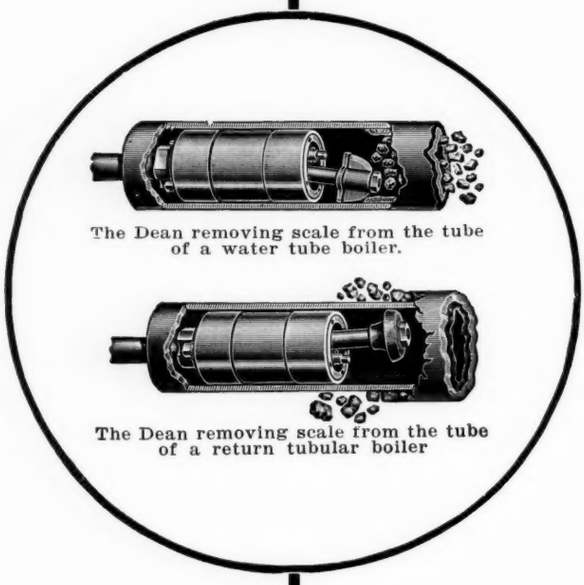

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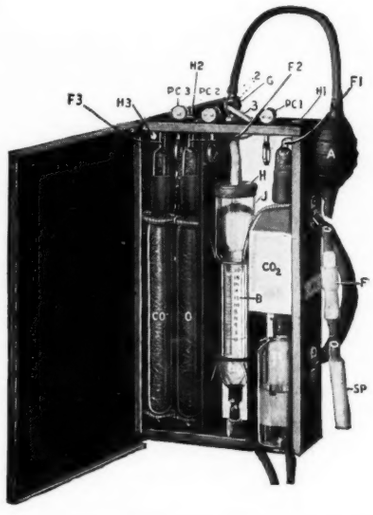

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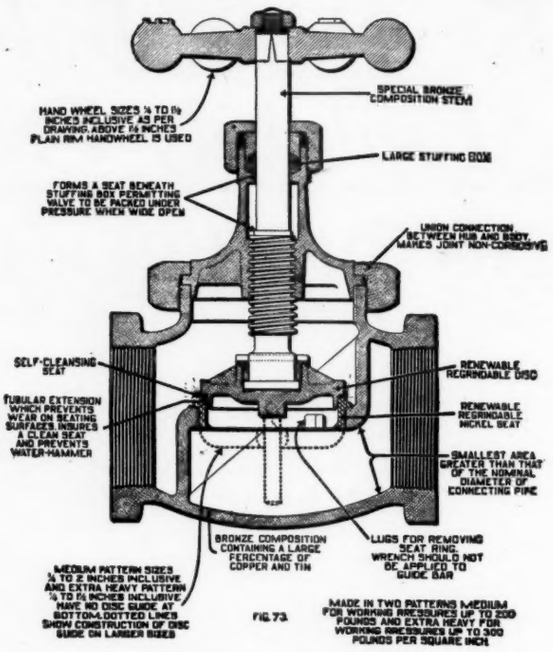
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FIG. 73
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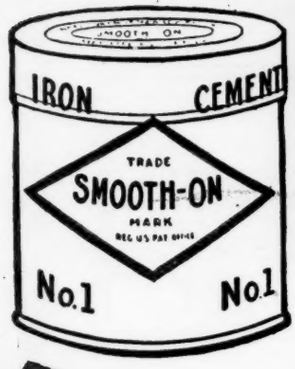

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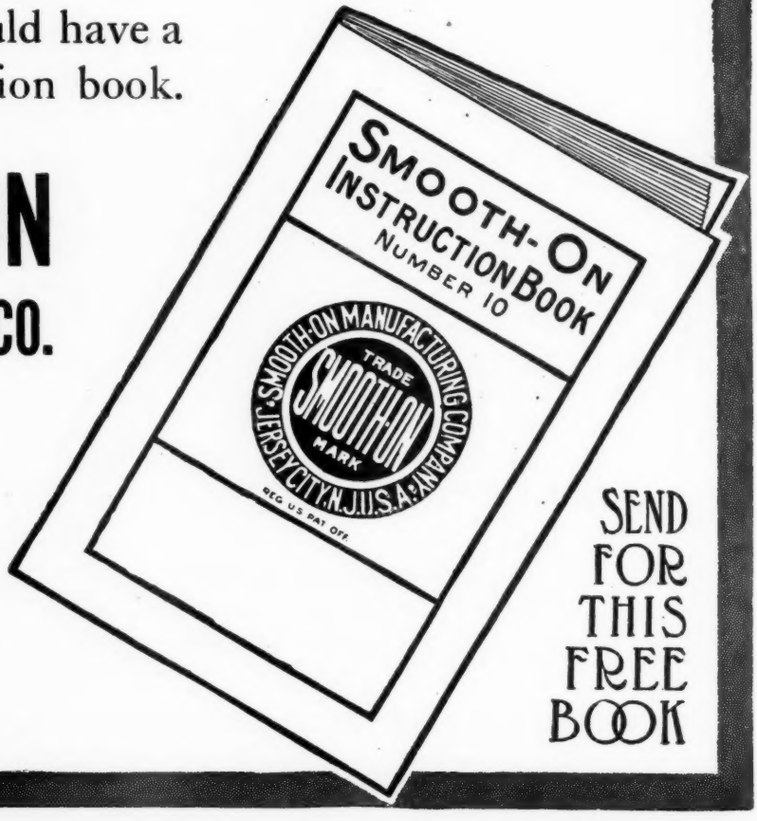

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POWER

Vol. 35 NEW YORK, APRIL 16, 1912 No. 16

TO know when to close your mouth, and keep it closed, is an art. It may be born in a man; it may be cultivated.

The man who cannot control his speech—just allows it to constantly dribble—is a Blabber. His former friends shun him, he is a disturbing element, and he ruins his chances for advancement.

A certain chief engineer on taking charge of a large plant was told by the superintendent:

"I want you to run this plant as you think best. I look to you for results only, and if your present force is, in your opinion, either negligent or incompetent, fire any one of them, or all of them. I am interested solely in the plant's operating efficiency, and it's up to you to deliver the goods!"

Soon the chief noticed that when the old man made his daily rounds the assistant engineer would hold him up and appear to be criticising and complaining.

The superintendent was a busy man and, quickly tiring of the assistant's complaints, told the chief that if "the valves are not set properly, if you are evaporating only seven pounds of water per pound of coal instead of nine, hadn't you better quit? It's up to you, chief."

The chief indignantly denied that these conditions existed and asked the old man who was his source of information.

"There he is," said he, pointing to the assistant, "fight it out!"

Mr. Blabbing Assistant was instantly discharged. "There's no room for both of us in this plant," said the chief; "you wash up and quit!"

Being a wise chief, he called the force together that night and told them what he had done, and why he did it.

"When a man has any information to impart, he must come to me; I am running this plant. When there is a suggestion to offer, a criticism to make, tell me. I want your respect and your confidence, I want everything to run smoothly, but I am your representative in the business office; you keep out. That's all."

The Blabber always gets found out; it's bound to come and misfortune naturally follows. Fight shy of him. He cannot keep anything to himself, and therefore cannot be trusted.

When you enter the plant to work for the boss, whether it be morning, noon or night, forget your outside affairs; when you leave it don't discuss your chief and his method of running the plant; be loyal.

No man can tame his own tongue but himself; each man is its sole guardian. A shut mouth denotes firmness and determination; an open one gives the impression of weakness, and is often "operated" by a fool or a knave.

White River Power Development

Part of the system supplying light and power to Seattle and Tacoma.

The special features of the development are the unusually large storage capacity and the hydraulic turbines which are the largest of their kind. They are of the inward-flow reaction type and are capable of delivering 20,400 h.p. at a head of 480 ft.

The Pacific Coast Power Co. supplies light and power to Tacoma, Seattle and neighboring towns as well as to the interurban railroad connecting these towns. The system formerly comprised two hydro-electric plants, the Puyallup station of 14,000 kw. capacity, located on the Puyallup River, and the Snoqualmie station of 18,000 kw. capacity, on the Snoqualmie River; these being supplemented by several steam plants located in the cities.

These two hydro-electric plants, however, have practically no storage capacity and due to the irregular flow of the Puyallup and the Snoqualmie rivers it was difficult to handle the ever-increasing load. An idea of the increased demand may be gained from the fact that the population of Seattle and Tacoma, together with their suburban towns, increased from 118,000 in 1900 to 435,000 in 1910, and probably now reaches the half-million mark.

To meet this demand and to provide a large reserve capacity, the White River development was planned. This serves also as a balance wheel for the entire system, the other two hydro-electric plants being run at full capacity all the time while the governing is done by the White River plant. Moreover, the latter is so situated that its transmission lines tie into the system at its geographical center.

The White River rises in glaciers on the north and east slopes of Mt. Rainier and drains an area of about 400 square miles. The present development is about 10 miles east of Tacoma and 25 miles southeast of Seattle, the diversion dam being built at a point near the big viaduct of the Northern Pacific R.R., north of Bulkley.

Because of much drift being carried by the river at flood stages, the diversion dam has been specially constructed, being broad and low and designed so as to permit the passage of drift without injury. The dam is of concrete with rock-filled cribs, 352 ft. long, and has a spillway its entire length. Concrete wing walls flank the dam on both sides and are placed so as to prevent the stream from changing its course.

The intake is of concrete with the opening parallel to the flow of the stream and a heavy boom protects it against floating débris. It is provided with grooves for stop logs and has mechanically operated gates driven by a gasoline engine.

From the intake a timber flume, 28 ft. wide and 8 ft. deep, with a slope of 7 ft. to the mile, conducts the water one mile to the first of a chain of lakes or settling basins. The water passes through these at a low velocity and deposits practically all the silt before reaching the outlet. Sluice gates are provided so that the basins may be drained and the silt sluiced out.

An unlined canal about 7000 ft. long conducts the water from the last basin across the flat top of the plateau. It then flows into a timber-lined canal, having a drop of 111 ft. in 2 miles, from which it enters a natural valley. Part of this drop may be used in the future for the installation of a secondary plant.

The water flows a considerable distance through this natural valley, then through a wide cut having a slope of 5 ft. to the mile, finally emptying into Lake Tapp's reservoir.

This reservoir, or natural storage basin, formerly included Kirkley, Church and Crawford lakes, together with numerous small ravines. These were inclosed by a number of embankments and the level of the lakes was raised 35 ft., thus making a large reservoir covering an area of 6 square miles and providing a stor-

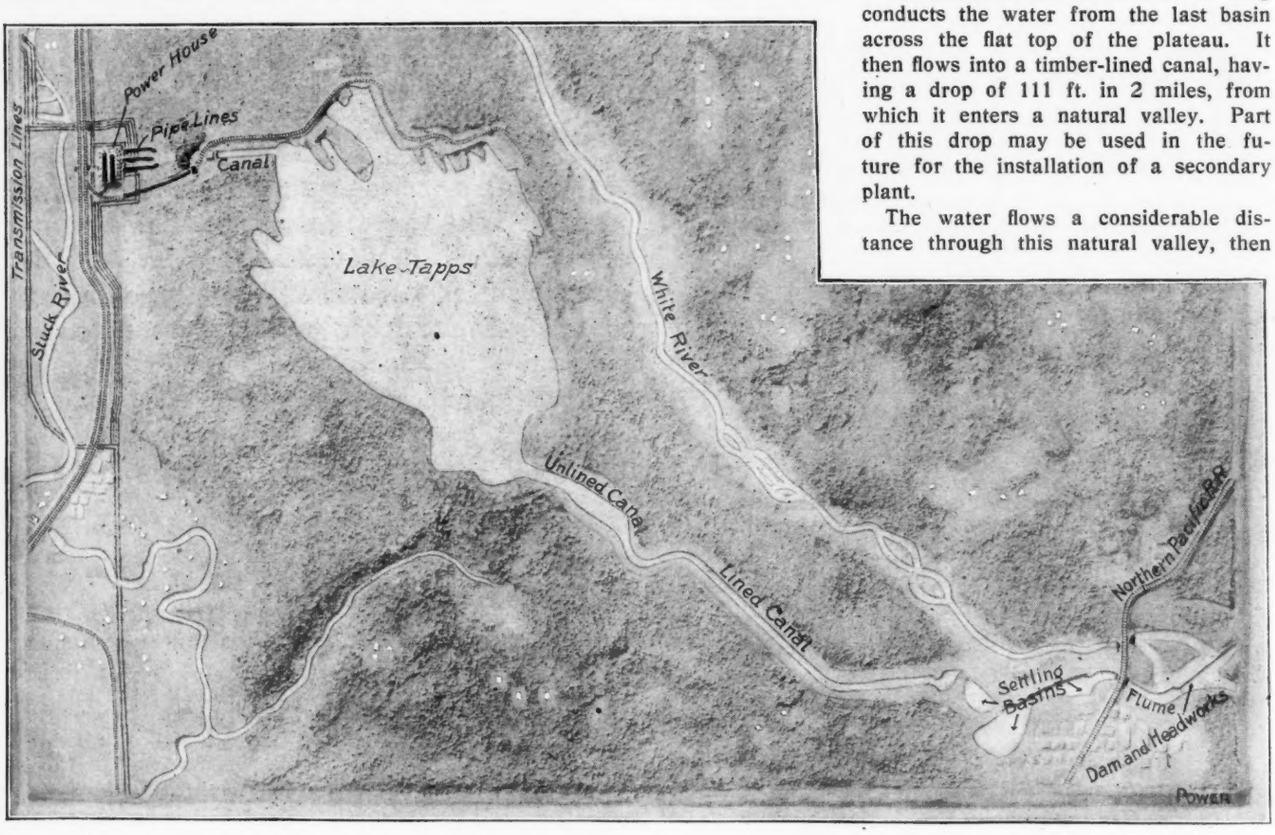


FIG. 1. RELIEF MAP OF WHITE RIVER DEVELOPMENT

age capacity of 2,250,000,000 cu.ft. of water.

The outlet from this reservoir is at the northern end. Here a timber-lined canal, 45 ft. wide and varying in depth to 90 ft., conducts the water a distance of 2500 ft. to the forebay at the entrance to the tunnel which extends through the western ridge plateau. This tunnel is 12 ft. in diameter, 2850 ft. long and concrete lined. The entrance portal is of concrete and has a bell-shaped mouth designed to reduce the entrance head to a minimum. Air shafts in the gate house, behind the gate leading to the tunnel, tend to prevent the production of a vacuum when the gate is closed.

The western end of the tunnel terminates in a circular forebay, located 250 ft. back from the brow of the hill, 75 ft. high, containing 2000 cu.ft. of air under 190 lb. pressure maintained by the static head. This air cushions the water column for each unit independently and permits governing without waste of water. The surge tanks are equipped with pivoted ball floats and valves, allowing the free passage in and out of the tanks but preventing the escape of air into the pipe lines. These tanks may be seen in Fig. 2, both at the brow of the hill and just back of the power house.

Main Turbines

Particular interest centers around the turbines since these are the largest high-head reaction turbines in existence. They were built by the Allis-Chalmers Co. and are each designed to develop 18,000 b.hp. at an effective head of 440 ft. and 360 r.p.m., but are also capable of delivering 20,400 b.hp. at a maximum head of 480 ft. They are designed to withstand the runaway speed at this head without undue strains upon any of the parts.

Two machines are at present installed and space is provided in the same building for two more. They are of the high-pressure Francis type with horizontal shafts. Water is admitted to the spiral casing from below and upon entering the runner is divided into two lines of flow and is discharged from the wheel by two quarter turns to separate draft tubes.

The spiral casing is made in two halves rigidly bolted together and is of cast steel tested to withstand a pressure of 385 lb. per square inch. To reduce the strain upon the casing an annealed cast-steel speed ring is provided. The two inner flanges of this ring carry the speed-gate covers which are bolted to the quarter turns and are bored out to receive the bearings for the pivoted guide vanes.

In order to avoid all obstructions to the free passage of the water at a high velocity and to provide accessibility, all sliding elements are placed outside the casing, employing what is termed the "outside-gate rigging." The guides are of steel with the pivots forged in one piece and project on either side through bronze bushed bearing and packing boxes to the outside of the speed-gate covers. The pivots on the side of the casing opposite the generator carry the levers which are connected to the central shifting ring by individual bronze links and stationary steel pins. The guide vanes are operated from the shifting ring, which has two substantial lugs carrying the pins of the governor connecting-rods. These rods are operated from bell-cranks rigidly interconnected and directly coupled to the main regulating lever and regulating piston.

If any foreign matter should locate between two guide vanes and thus prevent their closing, the governor ordinarily would concentrate its full energy upon the stems, levers and links of these vanes and would tend to deform them. This would call for dimensions of stems which would seriously interfere with the proper design of the guide-vane bodies and unnecessarily increase the friction of the whole gate rigging. The guide-vane stems and levers are, therefore, proportioned to resist only the pressure

Fig. 2. Power House, Showing Tailrace in Foreground and Surge Tanks in Background

and from here pipe lines convey the water to each turbine in the power house. The length of these pipe lines is 2000 ft., following the contour of the hillside, and the diameter varies from 8 ft. at the upper end to 6½ ft. at the lower. The thickness of the pipes varies from ⅜ to 1⅛ in. and the circumferential seams are double-riveted with triple-riveted double-butt straps on the longitudinal seams.

Extensive provision has been made against heavy surges or water-hammer in the pipes. For this purpose an open standpipe 6 ft. in diameter and 85 ft. high is placed at the upper end of each pipe line where it passes over the brow of the hill. The tops of these are 25 ft. above the high-water mark. Furthermore, at the lower end of each pipe line, outside of the power house, are placed two air chambers 7 ft. in diameter and

and strain resulting from the water pressure. To prevent the governor from imposing destructive strains upon the connecting links between the shifting-ring and guide-vane levers, the links are made of such a cross-section as to break at a predetermined stress. The guide vanes are so designed that they have a tendency to close to an opening at which the turbine will operate without load at about normal speed. A breakage of two links can, therefore, not materially affect the speed of the turbine and the two links may, therefore, be exchanged without necessitating a shutdown of the unit.

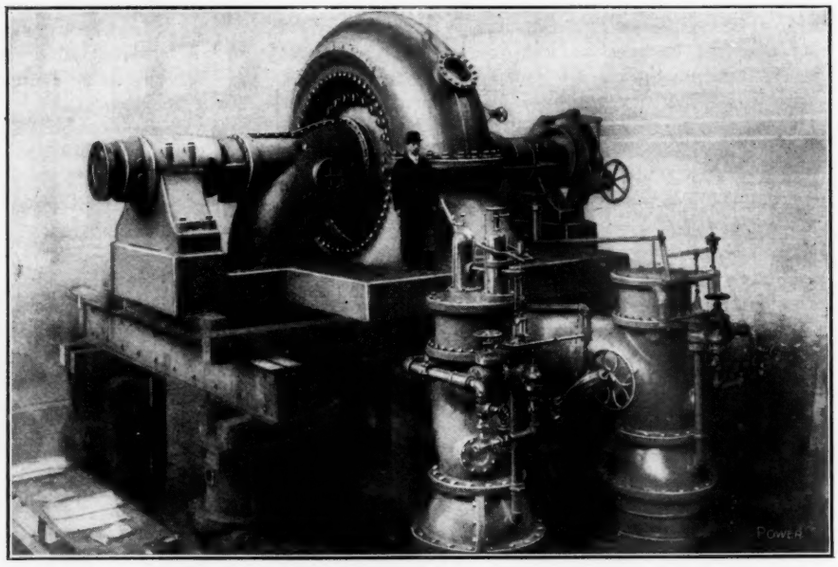


FIG. 3. OUTLET SIDE OF TURBINE, SHOWING PRESSURE REGULATORS

The turbine shaft is of solid openhearth forged steel and rests in ball-and-socket ring-oiling bearings. The driving end in the bearing has a diameter of 16 in., increasing to 32½ in. at the center flange to which the runner is bolted. The opposite bearing serves as a thrust and steady bearing, three substantial thrust collars being forged with the shaft in one piece. The greater part of the thrust, however, is balanced by employing the double-discharge design.

HAND-OPERATED FRICTION BRAKE

The turbine shaft carries the friction brake pulley and the brake yoke is mounted upon an extension of the bedplate. This brake is designed to bring all the revolving elements, at closed turbine gates with the casing under full pressure, to a stop from full speed in 5 min. and the friction surface and pressure are such that under these conditions all the heat produced is safely carried off to prevent excessive heating.

BUTTERFLY VALVES

Since each main turbine has its independent pipe line it was not necessary to provide for a gate valve, because the feeder pipe belonging to one unit can be emptied without interfering with the other unit. However, to provide for shutting off the water supply quickly in case of accident an 84-in. butterfly valve has been provided in each case between the supply pipe and the turbine. The immense size of this high-pressure butterfly valve is best comprehended by considering that a total load of over 2,000,000 lb. rests upon it under the test pressure of 385 lb. per square inch. A bypass is provided for filling the turbine casing and balancing the butterfly valve, and a drain valve is located at the lowest point of the inlet pipe by means of which the whole unit can be completely drained.

GOVERNORS

The governor for each turbine is of the oil-pressure type working in conjunction with the regulating cylinder shown in the illustration, the operating oil being furnished by a central oil-pressure system. The governor stand carries the speed control or flyballs, the floating lever, regulating valve, compensating relay dashpot and synchronizing attachment or switchboard control, and the motion is transmitted on top of the housing to the floating lever. The regulating valve is double acting and hydraulically balanced so that practically no energy is required to raise or lower the valve stem connected to the floating lever. A speed variation of ⅓ of 1 per cent. is sufficient to cause a motion of the gates. The regulating valve is returned into its "dead-beat" position by means of the floating lever operated from the compensating relay dashpot. The dashpot receives its motion from the relay connection of the regulating piston.

In order to limit the maximum gate opening of the turbine, when regulated automatically, a load-limiting device is provided so that the governor is prevented from opening the turbine gates beyond a desired amount. To enable

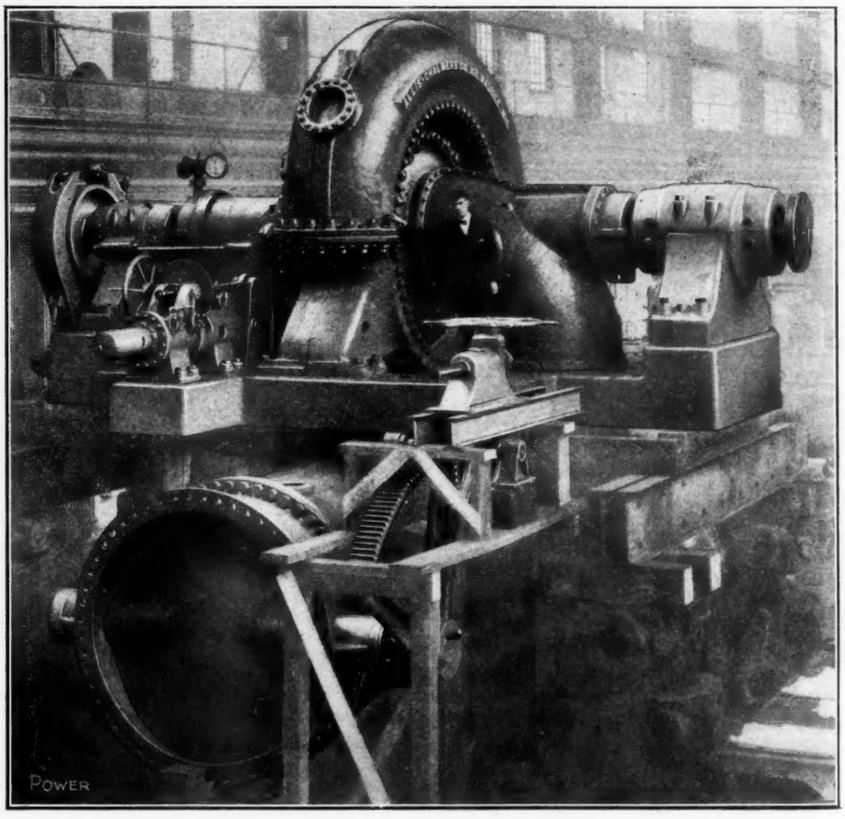


FIG. 4. INLET SIDE OF TURBINE, SHOWING BUTTERFLY VALVE

inspection or repairs to any part of the governor without shutting down the whole unit an independent hand-regulating device is provided. This is placed above the regulating cylinder and so connected with the extended regulating lever that it can be conveniently thrown in or out of operation.

Pressure Regulators and Bursting Plates

In order to protect the pipe line against serious pressure rises and to assist the governor in obtaining close speed regulation, pressure regulators are provided; these are both governor and pressure operated. Furthermore, to protect the pipe line in case of failure of either of these devices, a bursting plate is provided.

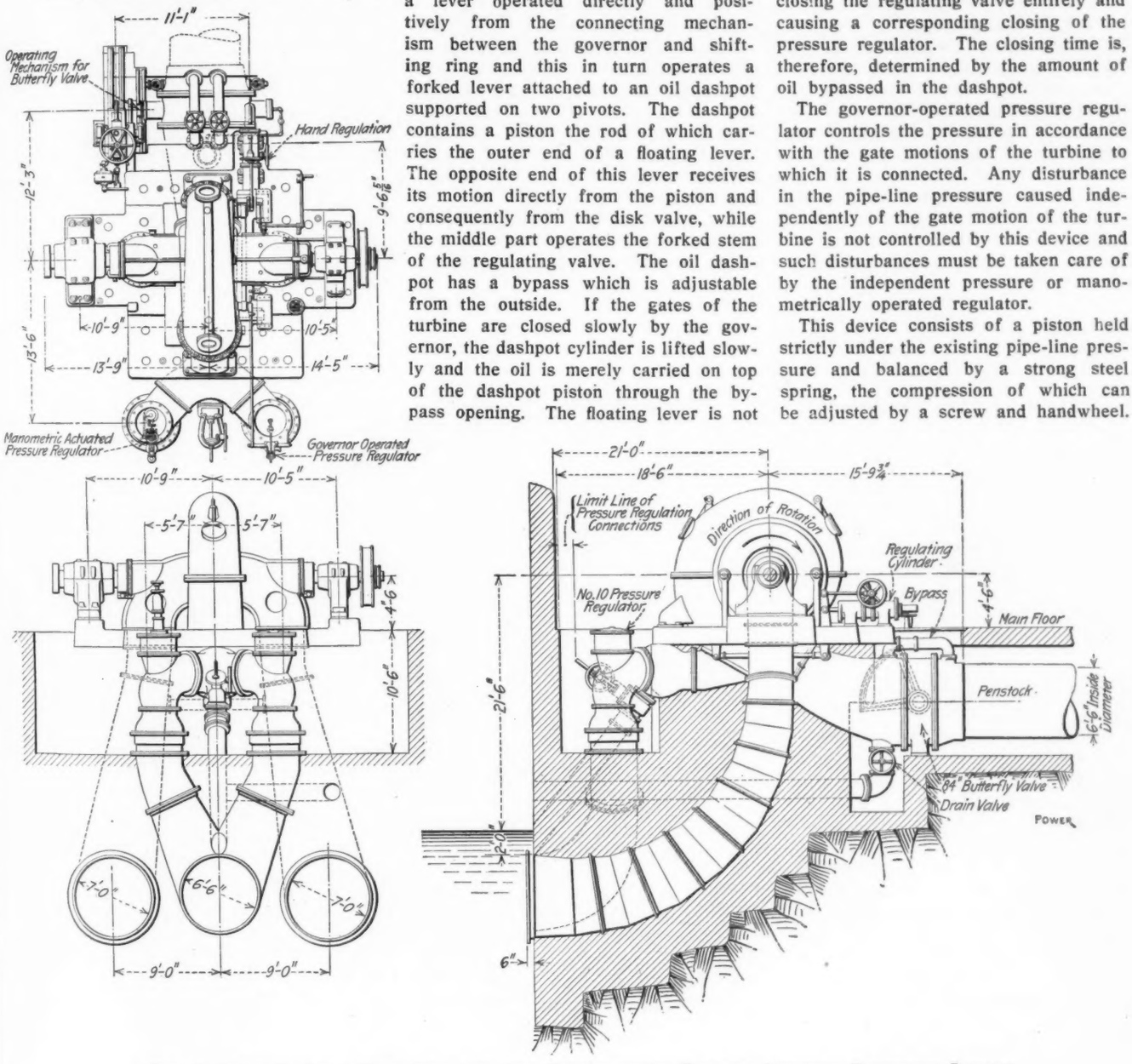
A Y-connection is attached to the bottom of the spiral casing, one branch leading to the governor-operated pressure regulator, the other to the pressure-operated regulator and the neck of the Y-pipe connects to a hand-operated gate valve which at its lower end carries the bursting plate and its discharge pipe. The discharge pipe from the bursting plate empties independently into the tail-race pit.

The principle and arrangement of these two pressure regulators is shown in Figs. 3 and 8. The governor-actuated device consists of a shaft carrying a lever operated directly and positively from the connecting mechanism between the governor and shifting ring and this in turn operates a forked lever attached to an oil dashpot supported on two pivots. The dashpot contains a piston the rod of which carries the outer end of a floating lever. The opposite end of this lever receives its motion directly from the piston and consequently from the disk valve, while the middle part operates the forked stem of the regulating valve. The oil dashpot has a bypass which is adjustable from the outside. If the gates of the turbine are closed slowly by the governor, the dashpot cylinder is lifted slowly and the oil is merely carried on top of the dashpot piston through the bypass opening. The floating lever is not operated, and consequently the pressure regulator is not opened.

If, however, the gate motion of the turbine is quick, due to a sudden reduction of load, the oil is not bypassed quickly enough, an over-pressure is created below the dashpot piston, thus raising the floating lever and causing a lift of the regulating-valve piston. The pressure is reduced below the piston and the valve opens; at the same time, however, the opposite end of the floating lever is lowered simultaneously with the opening of the disk valve and the regulating-valve piston is brought back toward its closed position, holding the disk valve in a balanced position. Due to the bypassing of the oil in the dashpot, the piston is allowed to move slowly in a downward direction, thus closing the regulating valve entirely and causing a corresponding closing of the pressure regulator. The closing time is, therefore, determined by the amount of oil bypassed in the dashpot.

The governor-operated pressure regulator controls the pressure in accordance with the gate motions of the turbine to which it is connected. Any disturbance in the pipe-line pressure caused independently of the gate motion of the turbine is not controlled by this device and such disturbances must be taken care of by the independent pressure or manometrically operated regulator.

This device consists of a piston held strictly under the existing pipe-line pressure and balanced by a strong steel spring, the compression of which can be adjusted by a screw and handwheel. This piston operates a lever which at its outer end carries the stem of the regulating valve. Any pressure rise will cause a compression of the spring, imparting an upward motion of the piston and the regulating-valve piston.



Figs. 5, 6 and 7. Plan View, End and Side Elevations of Turbine, Showing Governing Devices

To prevent the sand from interfering with the sensitiveness of the manometric device, the water pressure is not directly admitted to the cylinder but is carried into a pressure tank completely filled with oil so that this oil under pressure transmits any fluctuation to the manometric piston and spring and, due to its lubricating qualities, keeps it in perfect condition and sensitiveness.

Exciter Turbines

Each of the two exciter turbines is designed to develop 500 b.hp. at 420 ft. effective head when running at a normal speed of 400 r.p.m. and to safely withstand a runaway speed of 800 r.p.m. The wheels are of the impulse type with hand-adjustable needle-valve regulation and governor-operated deflecting hoods.

The deflecting hood consists of a forked lever hinged below the nozzle and carrying a removable knife-edged blade. This blade cuts into the jet from underneath in such a manner that the entrance edge is parallel to the axis of the jet, so that the upper, undeflected portion of the jet

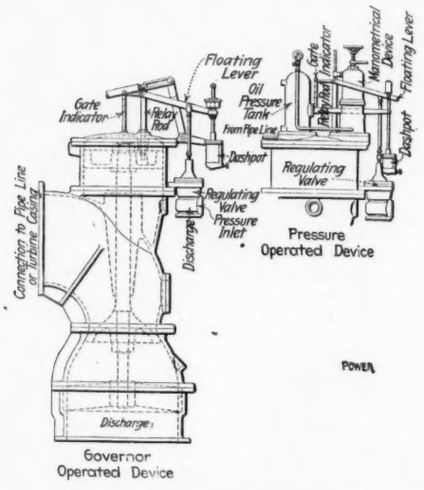


Fig 8. Pressure Regulator

impinges upon the buckets practically undisturbed, while the lower portion of the jet is deflected into the bottom of the wheel pit where it strikes a removable steel plate lining. The shaft of the deflecting hood projects through the wheel housing above the power-house floor, so that it can be directly connected to the regulating shaft of the governor.

The governor is of the self-contained Allis-Chalmers oil type, and is not connected to the central oil-pressure system but furnishes its own oil pressure for regulation. This enables independent operation of the exciter units so that the field can be held on the generators irrespective of the conditions of the governors of the main unit.

Oil Pressure System

For supplying oil under pressure three rotary gear pumps are at present installed, each of a normal capacity of 90 gal. per minute against a pressure of 400 lb. per square inch. Two are directly coupled to a 65-hp. induction motor, and the third is coupled to such a motor on one end and to an independent small impulse wheel of corresponding power on the other side. The pumps are of the double-stage type, the low-pressure stage picking up the oil from the receiver tank and discharging it at about 200 lb. pressure directly into the suction side of the high-pressure stage, which raises the pressure from 200 to 400 lb. per square inch and discharges into the pressure main.

Two independent receiver tanks of steel plate are provided which are partly set into the basement floor, so that all oil can discharge into them by gravity. Provision is made for liberal contact of the oil with air; the oil returning from the governors or safety valves discharges over a screen whereby it frees itself of air and all impurities as well as heat. The two receivers are interconnected by a pipe with proper valves so that the oil can be transferred from one tank to the other or the levels kept uniform.

A concrete pier between the two receivers carries the two main pressure tanks, which are of riveted steel plate and tested to 600 lb. per square inch and have a capacity of about 250 gal. each. A safety valve of the spring type is attached to each pressure tank and may be set to any desired pressure between 300 and 400 lb. per square inch; it discharges all excess oil directly into the receiver.

One main pressure pipe and one main return pipe carry the oil from the pressure tanks to the main governors and from there back to the receiver tanks. These pipes are of 4½ in. inside diameter and are made of seamless tubing annealed and bent with radii of at least 12 in. so that the flow of oil is not subject to abrupt changes in direction.

Two auxiliary pressure tanks are connected to the ends of the supply pipe in order to prevent a serious drop of pressure due to the acceleration of the oil in the long supply pipe between the pressure tanks and the governor. The two main and the two auxiliary pressure tanks are interconnected by an air pipe and to a motor-driven air compressor located in the basement. By means of this piping the air levels can be equalized between the various tanks or new air quickly supplied.

Electrical Equipment

The main generators are 6600-volt, three-phase machines, coupled direct to the turbines and rated at 10,000 kw. each. These were furnished by the General Electric Co. and under test showed an efficiency of 96.8 per cent. The exciters are each of 225 kw. capacity, furnishing direct current at 240 volts and are direct-connected to the impulse wheels. Provision has been made in extending their base plates for driving them by induction motors if this should be desired at any time.

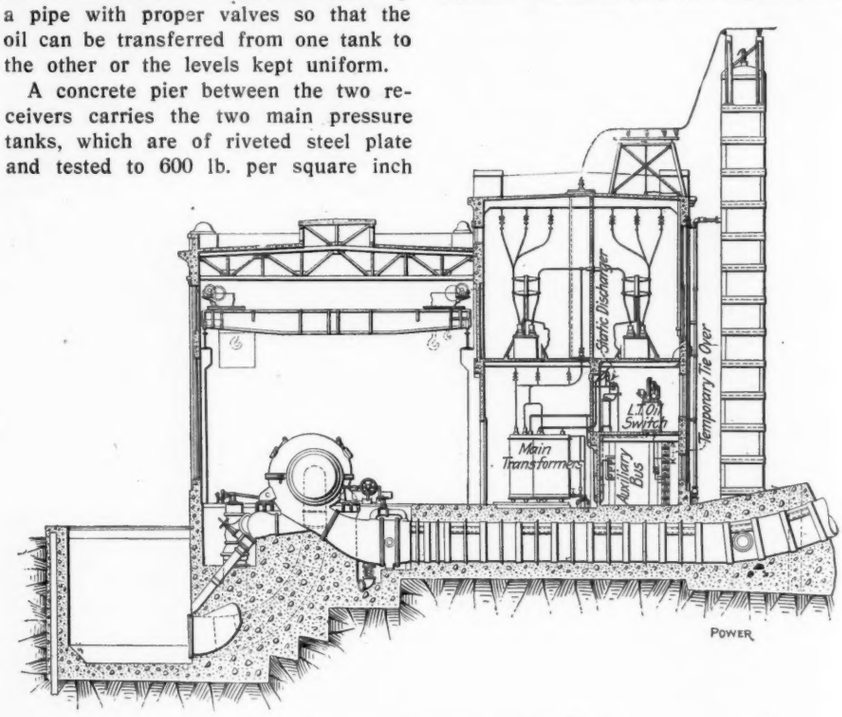


Fig. 9. Section through Power House

Water-cooled, oil-insulated transformers each of 3333 kw. capacity, step up the voltage from 6600 to 55,000. Three auxiliary transformers of 200 kw. each step down the voltage to 2300 for local power and lighting. In addition there are six 75-kw. transformers which step down to 220 and 110 volts. The usual form of high-tension switching apparatus and remote control is employed.

The engineering and construction work was carried on under the supervision of Stone & Webster, of Boston.

Kerchove and Uniflow Steam Engines*

Dr. Doederlein, of the Saechsische Maschinenfabrik, builders of the Kerchove engine, makes some comparisons between this type and the Stumpf uniflow engine, which show up the former to advantage.

*Translated and abstracted by William F. Monaghan from a contribution by Dr. Ing. Doederlein to Zeitschrift des Vereines deutscher Ingenieure of Oct. 7, 1911.

In 1893, Dr. Schröter, professor in the University of Munich, made a report† on investigations of a Kerchove compound engine, the surprisingly favorable results of which astonished the whole technical world. These tests were made on a single-crank compound condensing engine of 217 i.hp. at the works of the Société Anonyme van den Kerchove in Ghent with different loads and degrees of superheat.

The steam-consumption figures determined from a test on a Kerchove engine in 1902 with constant load and different degrees of superheat are shown in Fig. 1. The middle curve shows the steam consumption D_i in pounds per indicated horsepower per hour with increasing superheat. The bottom curve D_o gives the steam consumption of a "no-loss" engine, corresponding to complete adiabatic expansion of the steam from initial conditions before entrance into either the cylinder or the jacket to its terminal condition at exhaust. The top curve was obtained from the ratio corresponding with the reciprocal value of the indicated efficiency. For present use this ratio $\frac{D_i}{D_o}$ has been designated as "loss factor." The introduction of this new expression would prevent any further confounding with the ambiguous notation of the reciprocal value, variously designated as thermodynamic efficiency, indicated efficiency, efficiency ratio (Güteverhältnis), or cylinder efficiency (Gütegrad), which are referred to the pressure of the exhaust outside of the release valve.

If for a given design of engine the loss-factor curve is known, the steam consumption for any desired operative condition is easily determined, in that D_o is calculated with the help of the Mollier diagram and the result multiplied by the appropriate loss-factor.

If the series of tests represented by Fig. 1 is noteworthy in its low steam consumption, then the unusual course of the curve of steam consumption in Fig. 2 is especially prominent. Compared to such curves from other steam engines which with decreasing loads rise rather rapidly, that of the Kerchove engine drops with loads decreasing from normal to about half. The steam-consumption curve for the Kerchove engine runs almost parallel to that of the ideal engine, the falling off of the latter curve being incident to improvement of the vacuum through the lesser demand on the condenser. On the other hand, the loss-factor curve plainly shows that the internal losses of the engine decreases to nearly 70 per cent. of the normal load; thereafter slowly increasing.

For these qualities, so valuable for the operating conditions of varying load and continued underload, the Kerchove engine is indebted to its generally efficient design, but mainly to the piston valve which renders possible the opening and closing of the steam passages, even at short cutoffs, at the highest speed, preventing thereby throttling of the inflowing steam. Such a high degree of economy with a reciprocating steam engine had not before been attained nor considered possible; hence the Schröter investigations were at the time regarded as inapplicable laboratory tests, and their reliability was strongly doubted. However, the numerous tests made on the Kerchove engines turned out by the Sächsische Maschinenfabrik proved that the steam-consumption figures of the Schröter tests were not only equaled by the present-day Kerchove engines in practical, continued operation but, in many cases, were lowered.

Recently there appeared on the market the so called "uniflow" engine which under the Stumpf design is being turned out by first-class engine works and, at least in economy, is found in favorable competition with the compound engine. It is therefore interesting to compare the economies of the uniflow and the Kerchove compound engines. Here again, however, only such engines should be selected for testing as have a close agreement of exhaust pressures and depart not too widely from those of the Kerchove engines.

Although the steam-consumption figures of the compared uniflow engines vary but slightly from those of the Kerchove engines, the comparison having been obscured by the different conditions of operation, such as very high pressures and superheat and excellent vacuum, nevertheless on comparing their loss factors the distinctive economies of uniflow and Kerchove engines become plainly evident.

In wise recognition of the thermal advantages of the Kerchove engine, such as inclusion of the valves within the cylinder heads with its resultant minimum clearances and surfaces and the ample jacketing of the heads with live steam, the uniflow engine adopted them, and therefore must not be compared with a compound engine of ordinary design solely on a basis of its unidirection of steam flow.

In technical circles the conviction is constantly gaining ground that the results from the uniflow engine are due to this design and not to the doubtful thermal advantages of the uniflow direction of the steam. The chief advantage ascribed to it is the more favorable cylinder temperature at the end of the stroke. This, however, on closer examination of the quality of the steam, seems very unlikely inasmuch as in a

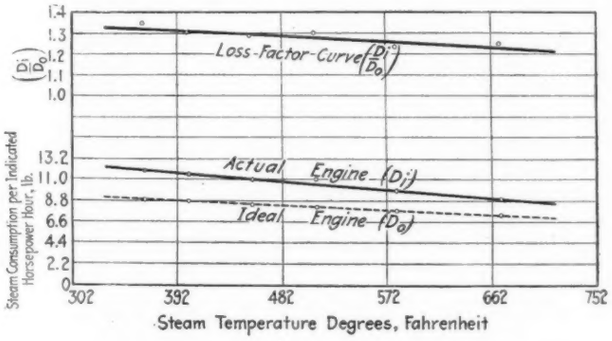


FIG. 1. STEAM CONSUMPTION AND LOSS FACTOR CURVES PLOTTED AGAINST TEMPERATURE

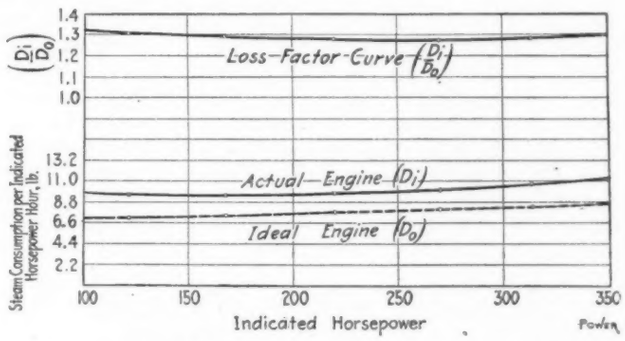


FIG. 2. STEAM CONSUMPTION AND LOSS FACTOR CURVES PLOTTED AGAINST HORSEPOWER

†Zeitschrift des Vereines deutscher Ingenieure for 1893, page 1281.

condensing engine the steam at the end of the expansion is fairly wet, so that at the jacketed head there should be, at most, a drying but no material superheating.

Proportional to its pressure and throughout the cylinder the steam has, then, a temperature of vaporization of from 122 to 140 deg. F., so that also in the uniflow engine the heated wall surfaces are in contact with cooled steam. Of course, in the uniflow engine the cylinder head is less exposed to the outflowing steam; in place of which, however, even if for lesser time, are the unheated piston surfaces, the cooling of which can work still greater thermal disadvantage than can that of the head surfaces. Hence in the uniflow engine as compared with the "reverse flow"* engine the cylinder heads and pistons have merely exchanged places, and in view of this the uniflow engine has no recognizable advantage.

measure of such adjustment, the duration of the exhaust being also a factor; and this in the uniflow engine extends over, at most, 10 per cent. of the stroke, while from 80 to 90 per cent. is provided in the reverse-flow engine.

From all tests made so far, the unusually low vacuums necessary with the uniflow engine for minimizing the compression have reduced the steam consumption but relatively little; for with an economical cutoff expansion cannot be sufficiently utilized in a reciprocating engine, a condition in no way changed by the uniflow design.

Although from observations of Stumpf the uniflow almost entirely prevents cylinder condensation, he has of late added jacketing and claims to have thereby obtained material improvements. This seems a counterproof against the stated thermal advantages of the uniflow design.

In engines with a good vacuum and tight valves the compression remains within allowable limits; under favorable conditions, however, it easily exceeds the initial pressure, and with free exhaust the clearances must be materially increased so that the uniflow engine with atmospheric exhaust operates with less economy than a single-cylinder reverse-flow engine.

Accordingly, the only undoubted advantage of the uniflow engine came into existence through the discontinuance of the exhaust valve and its clearance; an advantage inversely, of course, as the tightness of the exhaust valve and the degree of superheat of the incoming steam. The unusual cylinder and piston lengths of the uniflow engine are a disadvantage in comparison with the reverse-flow engine, for the temperature differences between the middle and both ends of the cylinder are conducive to unequal expansion and its resultant operating difficulties.

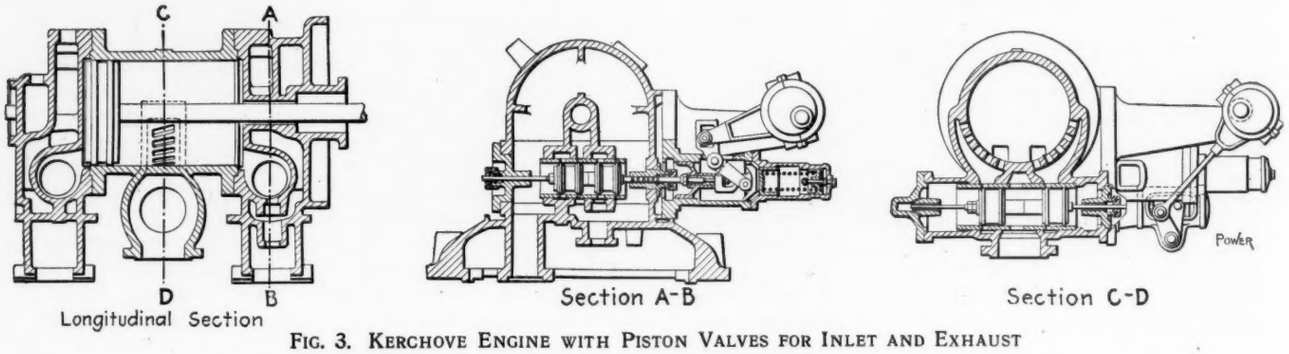


FIG. 3. KERCHOVE ENGINE WITH PISTON VALVES FOR INLET AND EXHAUST

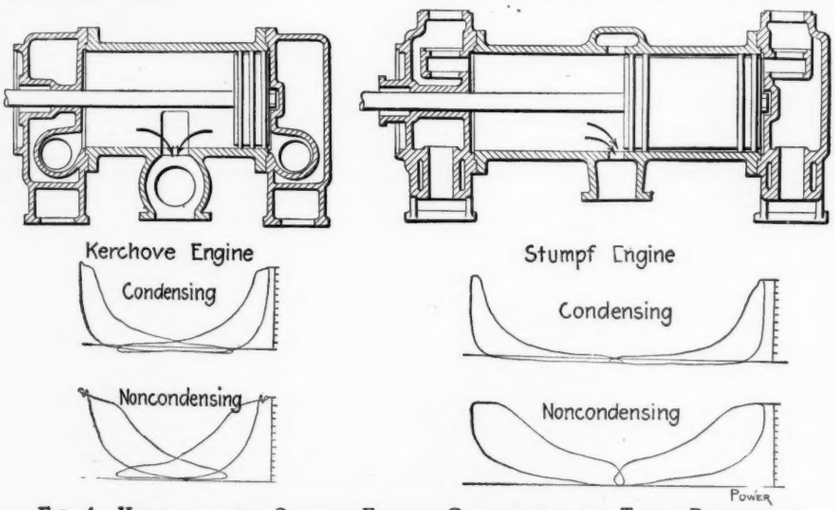


FIG. 4. KERCHOVE AND STUMPF ENGINE CYLINDERS WITH THEIR RESPECTIVE INDICATOR DIAGRAMS

A further preference ascribed to the uniflow engine is the relatively large cross-section of the outlet ports, resulting in a better adjustment of pressure between the cylinder and the condenser. Cross-section alone, however, is not a measure of such adjustment, the duration of the exhaust being also a factor; and this in the uniflow engine extends over, at most, 10 per cent. of the stroke, while from 80 to 90 per cent. is provided in the reverse-flow engine.

*The term "reverse flow" is used to designate the steam path in the cylinder of an ordinary reciprocating engine in contrast to that designated by the term "uniflow."

In order to utilize the advantages of the uniflow engine and avoid its disadvantages, the Sächsische Maschinenfabrik applied in 1909 for a patent on a new engine design, shown in Fig. 3. This shortened uniflow engine has the exhaust port not at the end of the stroke but approximately at the middle, in consequence of which a release valve is obviously required to close the port during expansion. Fig. 4 plainly shows the different cylinder and piston lengths of both designs; and, as is evident from the diagrams, the temperature and pressure of the expanding steam are already so low at release that there is neither a noticeable pressure drop nor condensation loss resulting from the increase of detrimental volume due to the use of the valve. For high speeds the engine is built with a shaft governor and positive valve-gear and piston valves are used; those for admission being located horizontally in the bottoms of the cylinder heads which are jacketed by the inflowing steam. The Sächsische Maschinenfabrik has had such a uniflow engine in operation on its testing floor for some time, and the principal results determined from duty tests are as follows:

Initial steam pressure, pounds per square inch	152
Steam temperature at the throttle, deg. F.	498
Back pressure in the cylinder, pounds per square inch absolute	2
Heat consumption, B.t.u. per lb. of steam	269.15
Steam consumption, pounds per i.hp.-hour	11.48
Heat consumption for 592 deg. F., B.t.u. per pound	335.47
Steam consumption, referred to 572 deg. F.	10.93

The value of the loss-factor shows nearly the same economy for this shortened uniflow engine as for the Stumpf design.

An important consideration peculiar to this engine is the three-part design of the steam cylinder made up of the cylinder proper and the two valve-containing cylinder heads. Fig. 5 shows such a cylinder with a steam jacket for which the live steam enters at its bottom midlength and flows into and out of the heads. Particularly noteworthy is the absence of all attachments and ribs in the cylinder proper, avoiding harmful stresses under high temperatures. Fig. 6 shows an inner view of a head. In Fig. 7 will be noted the close proximity of the valves to the piston, also the small clearances, the axial inflow of the steam and the ample jacketing of the cylinder heads by the entering live steam.

A second and equally important means for the attainment of high economy, particularly with underloading and with continued operation, is the piston valve as a cutoff and regulating device.

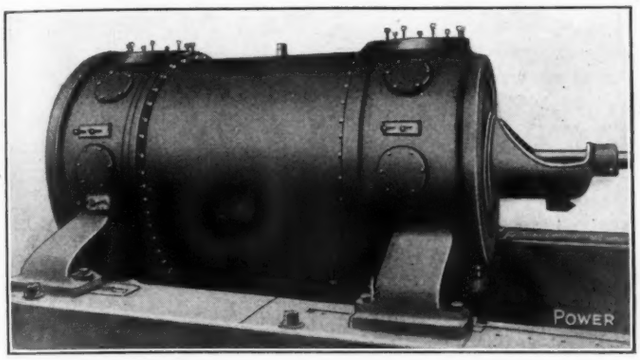


FIG. 5. STEAM JACKETED CYLINDER

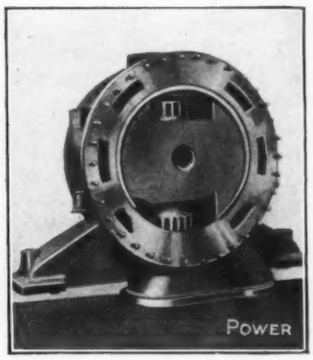


FIG. 6. INTERIOR VIEW OF CYLINDER HEAD

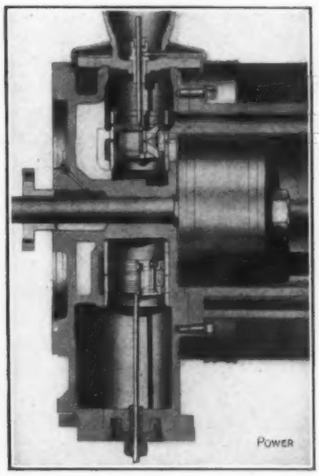


FIG. 7. VALVES AND PISTON

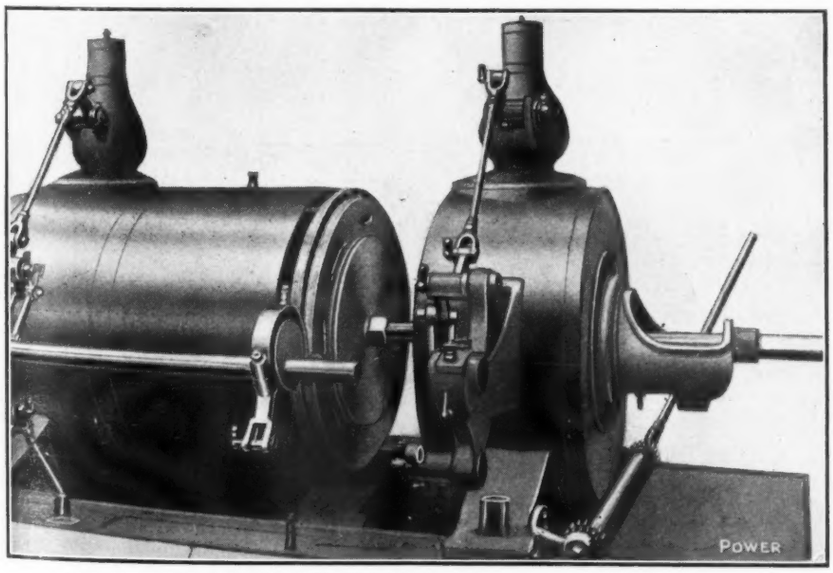


FIG. 8. METHOD OF REMOVING CYLINDER HEADS

The high-pressure cylinder is fitted with a releasing gear actuated by a single eccentric for admission and release. Through the different lengths of the roller levers which regulate the cutoff and the correspondingly different bends of both latches there is an automatic and almost perfect equalization of the cutoff at all loads for both ends of the cylinder; and through a suitable arrangement of the path of the roller there is, further, a very favorable apportionment of the cutoff throughout the whole travel of the governor.

The low-pressure cylinder is usually built with a positive gear, but if steam is to be taken from a receiver it is provided with a releasing gear like that of the high-pressure cylinder. A pressure regulator is placed on the control shaft of the high-pressure cylinder while a centrifugal governor determines the cutoff for the low-pressure cylinder. The pressure regulator is set below the pressure in the receiver and lengthens or shortens the cutoff in the high-pressure cylinder as the demand on the receiver is respectively increased or diminished.

The competitive introduction of the Kerchove engine in Germany was opposed mainly by the pretended difficulty of access to the interior of the cylinder. Experience, however, has very much lessened this objection, especially as by means of the simple contrivance illustrated in Fig. 8 the cylinder heads can be moved back. The cylinder rests on a cast-iron frame having planed slots which accurately guide the heads in their withdrawal. This can be accomplished, even with the heaviest engines, by one man with the aid of the pinion and ratchet bar attached to the head supporting lugs. The unity of that part of the valve-gearing integral with the head is not disturbed, as all that is necessary is the removal of two bolts to free it from the eccentric located on the control shaft running alongside of the cylinder.

Lunkenheimer Cast Steel Valves

Superheat and high steam pressures have created a demand for valves of great strength and durability, and anticipating the requirements the Lunkenheimer Co., Cincinnati, Ohio, has designed a complete line of globe, angle, cross, gate, check, nonreturn boiler stop valves, etc., made of cast steel for such use.

With the exception of the largest sizes, these valves are made of crucible steel and are annealed to relieve internal stresses. It is claimed that these valves contain less than 0.05 per cent. of either phosphorus or sulphur. Their tensile strength is about 80,000 lb. per square inch, with a safe elastic limit and excellent elongation.

For various pressures and degrees of superheat and to meet the requirements of engineers who differ as to the material used, these valves are made in two combinations of material as regards the trimmings.

The March issue of *The Engineers' List* contains a record of 26 buildings in New York City which have abandoned Edison service and are now operating private plants, having found the latter more economical.

Tom Hunter, Hoisting Engineer

By Warren O. Rogers

The engineer has a thrilling experience when a piece of gasket prevents closing the throttle while men are being hoisted in the cage.

A loose pin put the reversing gear out of operation on another occasion.

Ignorance in adjusting the steam valve pressure plate caused a serious accident and loss of life.

To the man who is unaccustomed to the methods employed in coal mining there is much of interest and instruction. Consequently I was anxious to see more of the mines, but it was several days before Hunter and myself again visited them, although we met at dinner each night.

A perusal of the daily papers shows that coal mining is a far from safe occupation, for scarcely a day passes but that some poor fellow meets with an accident, and doubtless many more occur, an account of which is never published.

One evening a news item related how a headman at a nearby colliery had fallen 900 ft. to the bottom of a shaft. I read the item to Hunter, who replied:

"That fall never hurt the man, for he had lost consciousness before he struck the bottom. He didn't suffer half as much as I once did while hoisting a cage carrying miners and could not get the throttle valve shut.

A Piece of Gasket

"Most throttle valves are arranged midway between the two cylinders, either on the overhead pipe, or in a pit between the engines. Ordinary rubber gaskets are used in making up the joints, and the plant I was running at that time was no exception to the rule.

"The engine had been working all right during the day, and there was no sign of trouble until the cage and the men were nearing the top. When I closed the throttle I found to my horror that I could not shut the steam off from the engine.

"There was but one thing to do—control the engine by means of the reverse lever. The engine was reversed, and as soon as it came to a stop the cage began to descend, and before it reached the bottom of the shaft it was again reversed. The men were thus hoisted up and down until help was obtained and the steam shut off from the engine by means of a separate valve in the steam line. When the valve was examined a piece of sheet packing was found between the valve disk and the seat which allowed enough steam to pass through to run the engines at a fair speed."

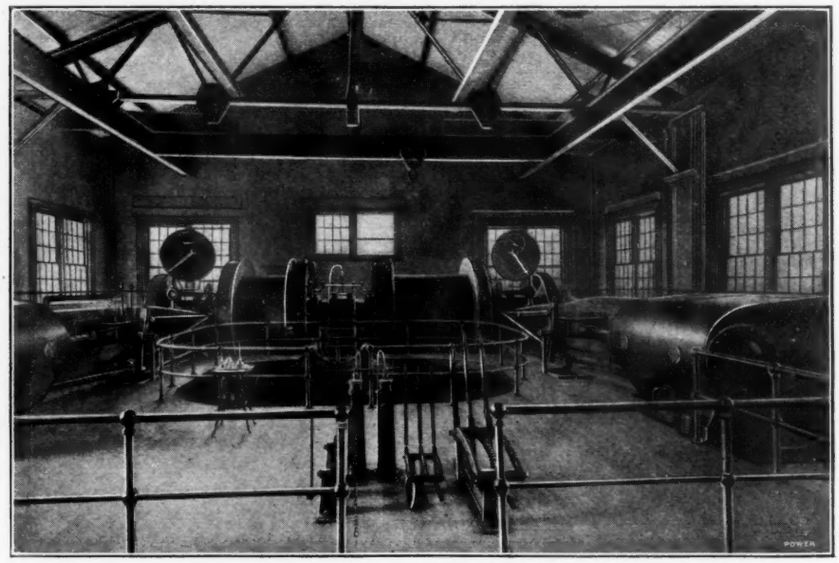
"Where did the piece of rubber gasket come from?" I inquired with interest.

"I never found out," said Hunter, "but I suppose it was from some loose end that had never been cut off when the gasket was put in."

I smoked a while in silence, wondering why Hunter had not stopped the engine instead of lowering and hoisting the cage until the steam supply was cut off. I finally put it to him.

Open Eccentric Rods

"I couldn't stop," he answered, "because the eccentric rods on that particular engine were arranged open; that is, with the link and reversing gear in mid-position, the eccentric rods were not crossed and consequently the valve on one cylinder was open or had lead. Had the piston rods been arranged to cross when the link was in mid-position, there would not have been lead on the cylinder and the engine would have stopped without any trouble."



There Are Many Levers to Handle, Dials to Watch and Signals to Obey

"As I understand the case," I said, "with the eccentric rods crossed, the steam ports of both cylinders are closed when the link is in mid-position, and the steam cannot enter either of the cylinders."

"That is it exactly, and why more engines are not arranged that way is a question I cannot answer."

"These miners must have said a few things," I remarked.

Pin Worked Loose

"Not so much as some others did at another time," was the reply. "I was hoisting the men slowly, as was my custom, and if the cage had been coming up at the rate of speed with which coal is hoisted those men would have required a parachute with which to make a landing.

"You have noticed that the link motion is actuated by an auxiliary cylinder, the link being lifted by an arm which is connected to a short lever by a pin passing through both.

"For some reason—probably carelessness as much as anything else—I neglected to examine my engines that morning and, of course, that was the time something had to happen. Accidents come as quickly with hoisting engines as with any other kind of machinery. In this instance the engines had been operating all right during the day, and it was not until the men started to come up that anything went wrong. Four loads of men had been hoisted, and the fifth was on the way when I began to ease up on the speed and found that the engines would not plug or reverse.

"It occurred to me that the trouble was in the reverse gear, and, as there was nothing else to do, I shut off the steam, applied the brakes, and stopped the engines with the cage about a foot from the top of the headwork. I found out later that the pin in the lifting arm had worked out of place."

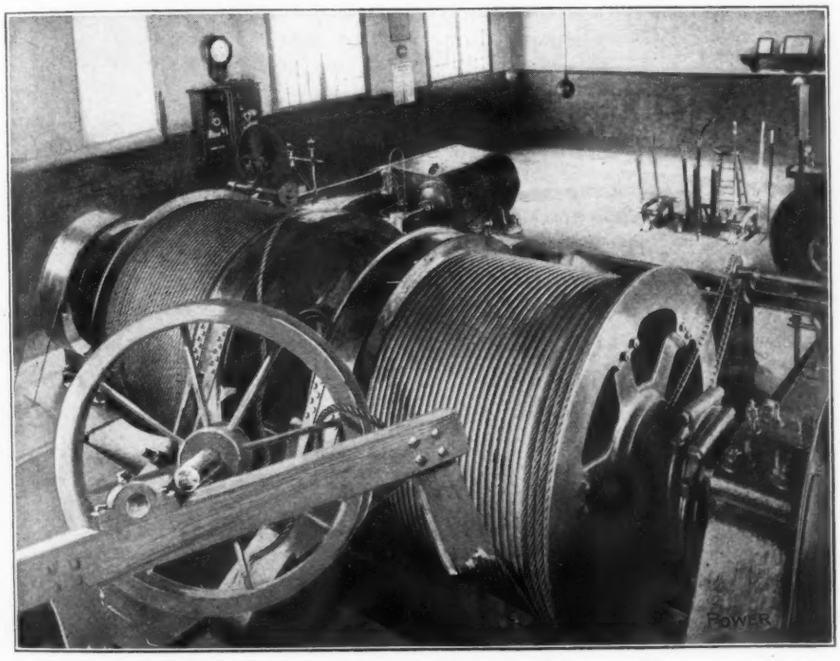
"I guess those miners got a scare coming up in that manner," I said.

"They did, and so did I, but a miss is as good as a mile. When the men found out what was the matter and how I had stopped they thought I was about the best fellow around the mine."

Guarding against Accident

"I have heard that most accidents occur from overwinding or hoisting the cage when it is at the top of the shaft. Why is that?"

"Because there are a good many levers to handle, dials to watch and signals to obey. One good way to avoid accidents of that character is to watch the winding rope as well as the indicator dial. Another preventive against accidents, in case there is doubt regarding signals, is to find out what signals were given before starting the engine. An engineer may have his attention called to some trouble about the plant; perhaps a crank-pin has been bothering him with heating and his mind is on that; he may think the signal to hoist has been given, and, without verifying the signal, start the engine and thus may cause an accident. If the time is taken to find out from both the footmen and the headmen what the last signals were, mistakes in signals are eliminated."



Fragments of the Cage and Head Works Were Drawn Into the Engine Room

Carelessness

"Men get careless, I suppose."

"They do, but sometimes ignorance has much to do with engine troubles. For instance, the side valve of many hoisting engines is fitted with a pressure plate, the purpose of which is to prevent the valve from slapping when the engine is running without steam.

"One day I decided that the plate was too loose and required setting up, and so before going home that night I adjusted it. The next morning before taking on men I started to run the cage up and down, as was my practice in order to make sure that everything was all right. I threw my reversing-gear lever over and happened to look at the link of the valve-gear at the same time. To my surprise, the link did not move, although the lever had been thrown its full travel.

"I tried it again and found that, although the rods controlling the steam valve on the auxiliary cylinder moved the valve of that cylinder, the piston did not move and, of course, the links which the piston operated failed to move. An examination of the cylinder failed to disclose anything out of order, and then I thought of the adjustment I had made of the pressure plate the night before, and that was where the trouble lay.

"After taking off the steam chest, I turned to do something else, and it was some time before I got to work on the pressure plate, so that it had cooled considerably before the adjustment was made. I adjusted it rather closely anyway and did not make allowance for the expansion of the valve when it was hot. The result was that when steam was admitted to the auxiliary cylinder at the reduced pressure used there was not enough pressure back of the piston to operate the valve and valve-gear, because when steam was admitted to the cylinder of the main engine the valve expanded between the valve seat and the pressure plate, and the friction was so great that the auxiliary cylinder could not move the valve. When the pressure plate had been loosened, the valve-gear operated as it should."

"Rather a close call. I will venture to say you never made another similar mistake."

Steam Valve Stuck

"I never made the same mistake again, but a friend of mine did, even after I had told him of my experience; in fact, he did the same thing. He had for years been in the habit of lowering men without testing his engine. The morning after he had adjusted the pressure plate of his engine he loaded the cage with men, and throwing his reversing lever in a position to lower he opened the throttle and sent the cage up to the top of the headframe, killing half a dozen men and injuring as many more. Before the engine was stopped, fragments of the cage and headworks had been drawn into the engine room through the side of the building and lodged under the winding drum. It was another instance of the auxiliary cylinder failing to operate the main valve-gear.

"That engineer made another mistake, one that is made by many others; that is, he opened the throttle valve too wide and got his engine going too fast before he had time to find out that it was going in the wrong direction."

By this time the waiter was standing on pins and needles waiting for a chance to clear up his table, and so we adjourned, Hunter to keep an appointment with a friend, while I went to a moving-picture show.

Reversible Steam Turbine

Another step has been taken in the perfection of the turbine, says the London *Standard*. Experiments and demonstrations have been made by Wainwright Brown on a reversible steam-turbine model 30 ft. long and about 18 ft. in breadth. It is reversed from full speed in one direction to full speed in another in a few seconds.

The reversing is effected by synchronized disks rotated by screw spindles extending outside the turbine casing which are made to open or close by nozzles which give the steam a left or right direction upon the blades.

Designs are now under preparation for the construction of a 2000-hp. machine on the new principle. It is the purpose of the inventor to adapt all sizes for the use of gas in place of steam.

Several large steamship companies have the new invention under consideration as a means whereby to increase the speed of their fast liners.

On Jan. 4, the load on the Chicago Commonwealth Edison Co.'s stations was 201,630 kw. Ten years ago it had passed the 20,000-kw. mark. The first figures probably reach the largest output of any electrical-supply system in the world.

Economy Factors in Power Plants*

By Charles Brossmann

A consideration of the various items which, apparently small in themselves, when taken together will seriously affect the economy of a plant if they are neglected.

*From a paper delivered before the Indiana Engineering Society.

Economy in the production of power in many small- and medium-sized plants is not given the same thought as in the larger plants. This is not always due to the equipment not being high grade, but rather to numerous losses which can mainly be attributed to inattention or lack of knowledge of the small details which, considered as a whole, are important. Very few have any reliable check on what they are producing and the cost thereof. Coal is purchased from the lowest bidder and perhaps a rough check is made as to the amount of water pumped, but it is seldom known whether each part of the plant is doing its share in an efficient manner.

Considering first the boiler room: with a certain grade of fuel and under certain conditions, a given number of pounds of water per pound of coal should be evaporated. To keep track of this the coal must be weighed and the water measured. The coal is best weighed between the bins and the boilers for in this way the amount can always be found without referring to that in the bin. The meter for measuring the water should be installed between the feed pump and the boiler in order that all water entering the boiler may be accounted for.

With means for weighing both the water and the coal, the evaporation of a certain coal will be known under proper conditions; that is, clean boilers and flues, proper draft, etc. If the evaporation should drop, say, from 8 lb. of water per pound of coal to 7 lb. with the same fuel, it would at once be apparent that something was wrong—either the coal was not up to the standard or the boilers were scaled or the tubes covered with soot.

Few boilers are operated with a minimum amount of scale, and with tubes clean both internally and externally. The accumulation of ⅛ in. of scale will make a difference of 15 to 18 per cent. in the evaporation and the accumulation of soot in return-tubular boilers with the corresponding loss due to drop in draft and insulation loss will add still further to this figure. The chart, Fig. 1, shows the approximate loss due to scale, based upon 320 days' operation per year with coal at different prices. For example: Suppose coal costs $2.50 per ton and six tons are used per day where the scale on the tubes is $\frac{3}{16}$ in. thick; the resulting loss will be $1000 per year. The loss due to uncovered steam piping is shown by the chart in Fig. 2. Suppose conditions under which there is 200 ft. of 6-in. pipe and the coal costs $1.85 per ton. Tracing on the chart as indicated by the dotted lines, the loss will be $180 per year. If magnesia lagging is used the saving will be

$$0.85 \times 180 = \$153$$

A very important factor that has much to do with the economy is the cleanliness and order of the boiler room. One usually finds poor economy in a dingy, dirty boiler plant. Inside cleanliness is more important, but the order outside is often the index of inside conditions.

There is quite a loss in many plants due to the boiler settings being cracked. All cracks admitting air should be repointed and small hair cracks can have a coat of thin paint or whitewash. All cracks around the iron work and in the breeching should be also stopped up.

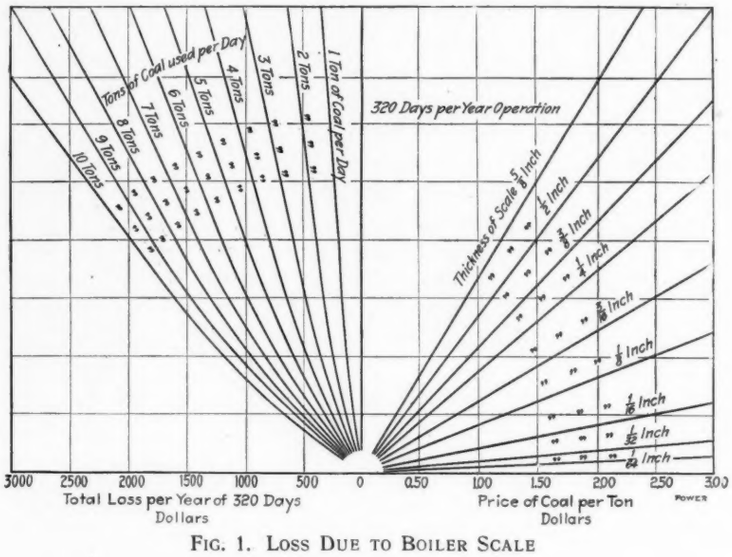


FIG. 1. LOSS DUE TO BOILER SCALE

FEED-WATER HEATERS

In a noncondensing plant the main exhaust can usually be connected to the heater. When a condensing plant is installed the steam from the air and feed pumps or other auxiliaries may be diverted to the feed-water heater. With an open heater, about one-sixth of the exhaust steam from the main engine will heat all the water from about 50 deg. to a temperature near the boiling point.

Where condensers are used it is often advisable to place a closed heater in the exhaust line between the engine and the condenser, discharging the feed water through this into an open heater into which the auxiliaries exhaust. The writer has seen closed heaters so clogged in the water space that nothing but a thin stream could trickle through. When such heaters are installed in connection with a condensing system they should be arranged with a bypass.

SUPERHEATED STEAM

It is surprising that more advantage is not taken of the use of superheated steam in pumping plants where the long stroke and slow speed of the engines make it especially suited to increased economy. Ordinarily, the efficiency of pumping engines can be increased from 5 to 25 per cent. by the use of superheated steam, and even with large high-duty triple-expansion engines a saving of 12 per cent. in steam has been recorded. For purposes of comparison it may be stated that the saving by using superheated over saturated steam will be approximately as follows for 100 deg. superheat: For a simple engine, about 15 per cent.; compound engine, about 14; triple-expansion engine, 12; steam turbine, about 10 per cent.

PUMPING PLANTS

It would be interesting to know how many pumping plants record each day the amount of water pumped, the pounds of coal consumed, the cost to evaporate 1000 gal. of water in the boiler plant, and whether the coal is doing the same or only one-half the work it did last month. Contracts are entered into for thousands of dollars' worth of coal per year and no means are taken to determine if 25 per cent. of the material is

worthless as fuel as compared to the sample car received. Again, the coal may be all right, but the plant may be in such a condition that 25 per cent. more fuel is required to do the same work. Such losses can usually be avoided either by a close inspection, by making the necessary tests at suitable periods and by a system of daily records, and the proper interpretations being made of such records; in regard to the latter, the personal factor is important. Constant and intelligent attention to the innumerable details of the plant cannot be slighted and have the plant operate satisfactorily. The superintendent cannot do all this, but the operating engineer directly in charge should be held responsible for his part.

Smoke

Legislation may minimize the smoke, but the ultimate desired results can never be accomplished without looking at the question as one of dollars and cents. In the first place the writer believes there is no such thing as a commercial smoke consumer, despite the fact of inventions and statements to that effect. Smoke cannot be commercially consumed, although it may be disguised or treated in such a manner that it has a less formidable appearance to the esthetic eye.

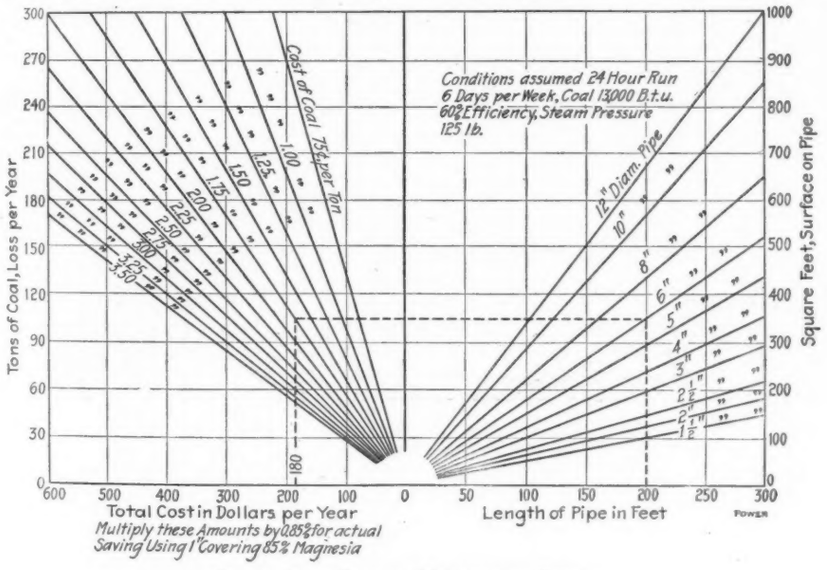


Fig. 2. Loss Due to Uncovered Piping

The only way to consume smoke commercially is not to make it, and engineers who have studied the problem recognize this as the first commandment in the smoke question. Smokeless combustion will not be general until the plant owner recognizes that he is wasting money.

Overloading boilers will not cause smoke; it is the lack of sufficient furnace space, coupled with the lack of appliances or improper methods of firing, which is directly responsible for the smoke. The common method of purchasing a boiler and building a brick wall around it and placing above a low stack—building the entire unit without regard to the ordinary principles of combustion—is the cause of great loss annually and probably does more to keep up the smoke-nuisance agitation than any other thing. The principles of combustion and the prevention of smoke are not mysterious.

To accomplish this it is necessary that all the products of combustion be consumed before touching the cold surfaces of the boiler. To do this requires good draft which means a high stack if natural draft is used. It means a properly designed furnace that should not be so cramped that gases cannot be properly burned before reaching the comparatively cold boiler and it means proper handling of the fuel whether by mechanical devices or by hand. Furthermore, the boiler should be properly set up so that in a year's time the settings are not full of cracks or crevices which admit air and contribute to the inefficiency of the furnace both as regards smoke prevention and economy of combustion.

Packing in Steam Plants

With the innovation of the steam engine came many accessories, most of which were crude in design, principle and material. None was more indispensable than packing for cylinder heads, steam chests, pipe-flange joints, etc. Up to about 1850 the most commonly used material was a composition of red lead, hemp and oil made into putty by the engineer or his helper and plastered on the flange joints, which were then screwed up tightly and the putty or packing was allowed to dry or set before the pressure was applied, which at this period did not exceed 60 lb. per square inch.

The next development was approximately in the year 1860, when cloth insertion packing was introduced, this probably being the first rubber or gum-sheet packing manufactured. It was composed of rubber composition with insertions of duck or sheeting, and was used between 1860 and 1875, when steam pressure did not exceed 80 lb. per square inch.

After this period came the plumbago and rubber compositions, called self-vulcanizing packings; this form had to be vulcanized or baked into the joint, a process requiring considerable labor, time and expense. They were more durable and satisfactory, however, under conditions then existing than preceding packings.

The next important advance made in the development of rubber-sheet packing was in 1886, when several semi-vulcanized rubber-composition packings appeared. These packings did not require as much baking in the joint and soon became popular.

A packing composed of rubber and asphaltum, which was suitable for water and other liquid conditions next claimed the engineers' attention.

During the period from 1900 to 1910, steam pressures have increased from 80 to 200 lb. and over in stationary plants. This increase has brought a corresponding rise in temperature which has been still further increased by the practice of superheating the steam. The wider use of the air compressor, ice machine, gas engine, superheater, etc., has also created extreme temperatures which demand a packing that can meet exacting conditions.

Composition packings have been perfected having great resistance to extreme heat as generated under high pressure. The basis of this material is pure asbestos fiber, the fibers being treated with a waterproof compound to prevent them from absorbing moisture. The composition is compressed under pressure into a compact homogeneous texture sheet packing in various thicknesses and of high tensile strength. Such a packing is unaffected by condensation from steam; and if properly made retains its pliable resilient qualities and does not become hard or brittle. It will, of course, conform to uneven surfaces and is suitable for gaskets on air compressors, and as packing so constructed is suitable for high-pressure and superheated steam, it is, of course, also suitable for use with low-pressure and saturated steam.

What demands will be made upon packing in the future remains to be seen.

Although in recent years the price of electric energy has been reduced under the stress of competition from the small isolated plant, the price of central-station service is still so high that only in exceptional cases can one afford to forego the cheaper and independent production by the private plant.—Prof. Josse, in *Neure Kraftanlagen.*

Electrical Department

Conducted to be of service to the men in charge of electrical equipment in the power house

A German Rural Power Plant

By Dr. Alfred Gradenwitz

In view of the more and more difficult conditions applying to German agriculture, there is an increasing necessity for using machinery in connection with most agricultural operations. This tendency has led to the installation of a number of rural power-transmission plants, with electric motors for driving the agricultural machines. A new development in this connection has been recently made by the installation of rural power-transmission plants in connection with embankments in the hilly country of East Germany, where no considerable heads are available.

The Radaune Valley embankment plant, between the sluices of Boelkau and Prangschin, near Danzig, is the first of these installations, and presents a number of interesting features. As there was no rocky soil to serve as foundation for a masonry dam, it was necessary to resort to an embankment containing a core of boulder marl, the slopes of which on the water side are protected by rubble in the lower third and by granite slabs in the two upper thirds against the impact of waves, whirls and floating objects. The opposite slope was fixed with turf on a layer of vegetable soil.

This embankment (see Fig. 1), the crest of which is 144 ft. above the average water-level of the Baltic and 57 ft. above the lowest level of the Radaune, allows the river to be dammed up to a height of 47½ ft., thus producing a basin of a normal capacity of about 120,000,000 cu.ft. and covering an area of about 173 acres. In order to enable the water-level to be increased or lowered, as the case may be, even emptying the basin, partly or entirely, a bottom discharge has been installed, traversing the embankment, which mainly consists of a big wrought-iron conduit 59 in. in diameter and a control gate. In order to prevent flooding in the case of high water, an automatic overflow or spillway was provided, consisting of an open canal which descends in cascades toward the river.

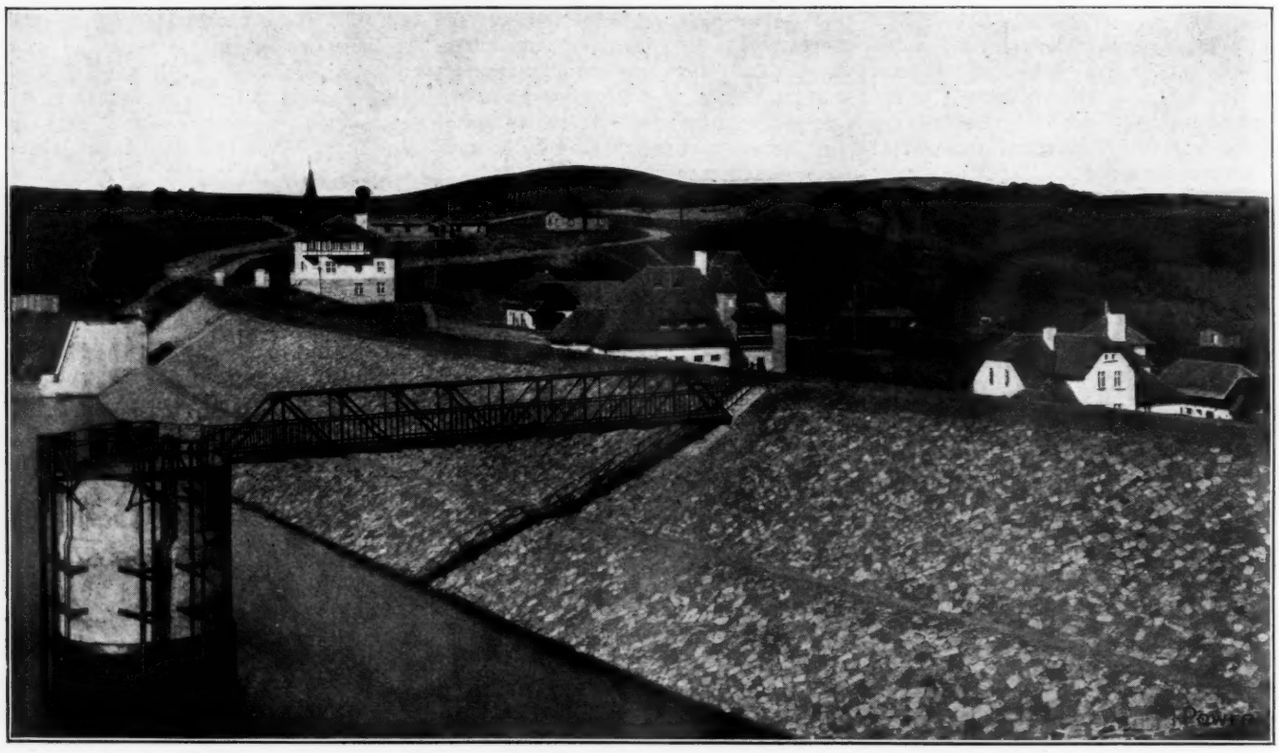


Fig. 1. Embankment and Power House; Discharge Gate is in Concrete Pit in Foreground

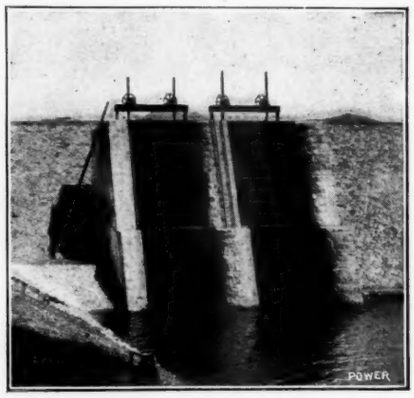


Fig. 2. The Head Gates

The power-house equipment comprises two self-contained generating sets, each of which has its own penstock, entrance gate and rake. Each penstock is controlled normally by means of a quick-acting gate fitted at the end immediately ahead of the turbine and operated from the generator room; this is used for starting, stopping and draining the turbine, the main head gate being used only for shutting off the entire penstock. Two iron-concrete conduits, 6 ft. in clear diameter and 131 ft. long, lead through the embankment to the main head gates. The water flows through these conduits at a maximum speed of about 6½ ft. per second. In front of the power house these iron-concrete con-

duits terminate in wrought-iron pipes of the same diameter.

The two turbines are Francis twin machines in steel housings with axial water admission and horizontal shafts. They are direct coupled to the electric generators. The rear bearing of each set is a thrust bearing and is accessible through the pit. The turbine shaft proper has only this one bearing, being rigidly coupled to the dynamo shaft by a forged-on flange; the complete turbine and dynamo set has only three bearings and is accordingly of relatively small length. The steel housings of the turbines are 98½ in. in clear diameter and are connected with the control valves by conical fittings. This arrangement greatly simplifies the water admission and reduces the loss of head between the rake and the turbine. In fact, the loss of head in the rakes, head gates, conduits and control gates is only about 12 in. under full load.

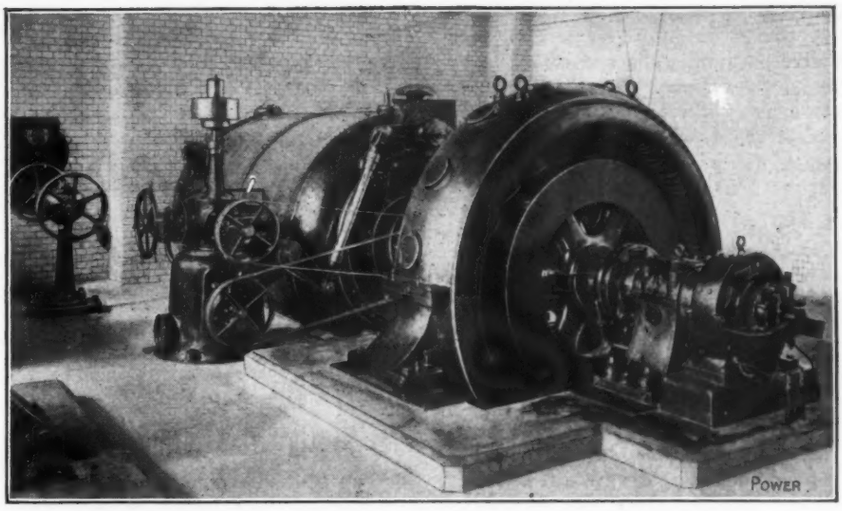


FIG. 3. A GENERATING UNIT IN EMBANKMENT POWER HOUSE

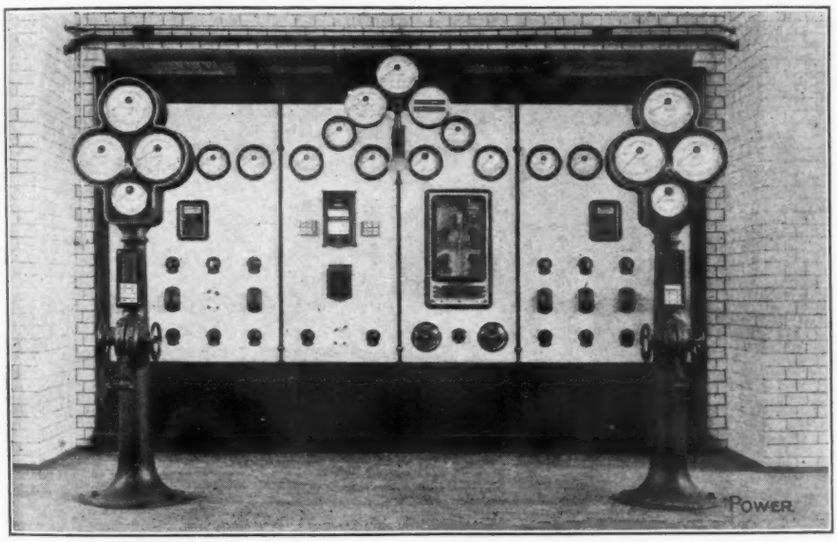


FIG. 4. SWITCHBOARD AND CONTROL COLUMNS IN POWER HOUSE

As the embankment is compelled to supply to the mills situated on the river the whole or a given portion of the water flowing into the basin, an electrical level-signaling device has been installed above the basin for indicating the water admission. This allows the amount of water flowing from the upper pond into the storage pond to be gaged at any moment. The water consumption of the turbines is recorded by Woltmann apparatus.

POWER HOUSE EQUIPMENT

The two three-phase alternating-current generators driven by the turbines are of the usual revolving field-magnet type with their exciters driven from the ends of the shafts, as shown in Fig. 3. The field magnets are excited at about 110 volts, and the machines deliver three-phase currents at 8000 volts and 50 cycles per second, running at 300 r.p.m. The output of each generator is 550 kw. with unity power factor. The exciters are 9-kw. dynamos. All of the electrical equipment is of Siemens-Schuckert manufacture.

The switch-gear is located in an annex, and all parts carrying high-tension current are placed in closed compartments, the plant being controlled in the low-tension circuits. The instruments and switch handles for starting and controlling the two generators are installed on two control columns located on a platform in front of the switchboard, as shown in Fig. 4. The synchronism indicators are located on a bracket in the middle of the service switchboard, so as to be easily observed from either control column. The service switchboard comprises four marble panels and is built into the middle of the wall facing the machinery. Immediately behind the switchboard are arranged the field rheostats of the exciters. The high-tension

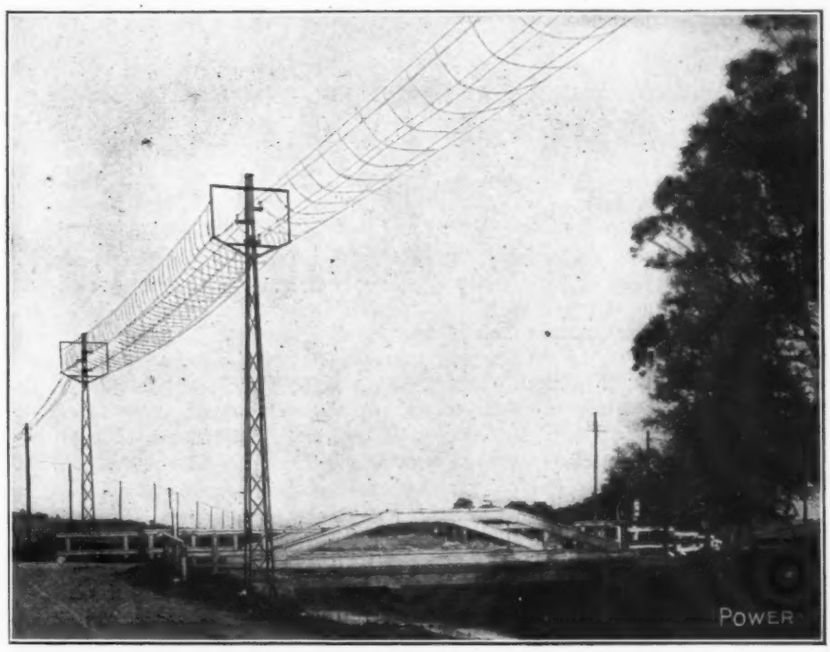


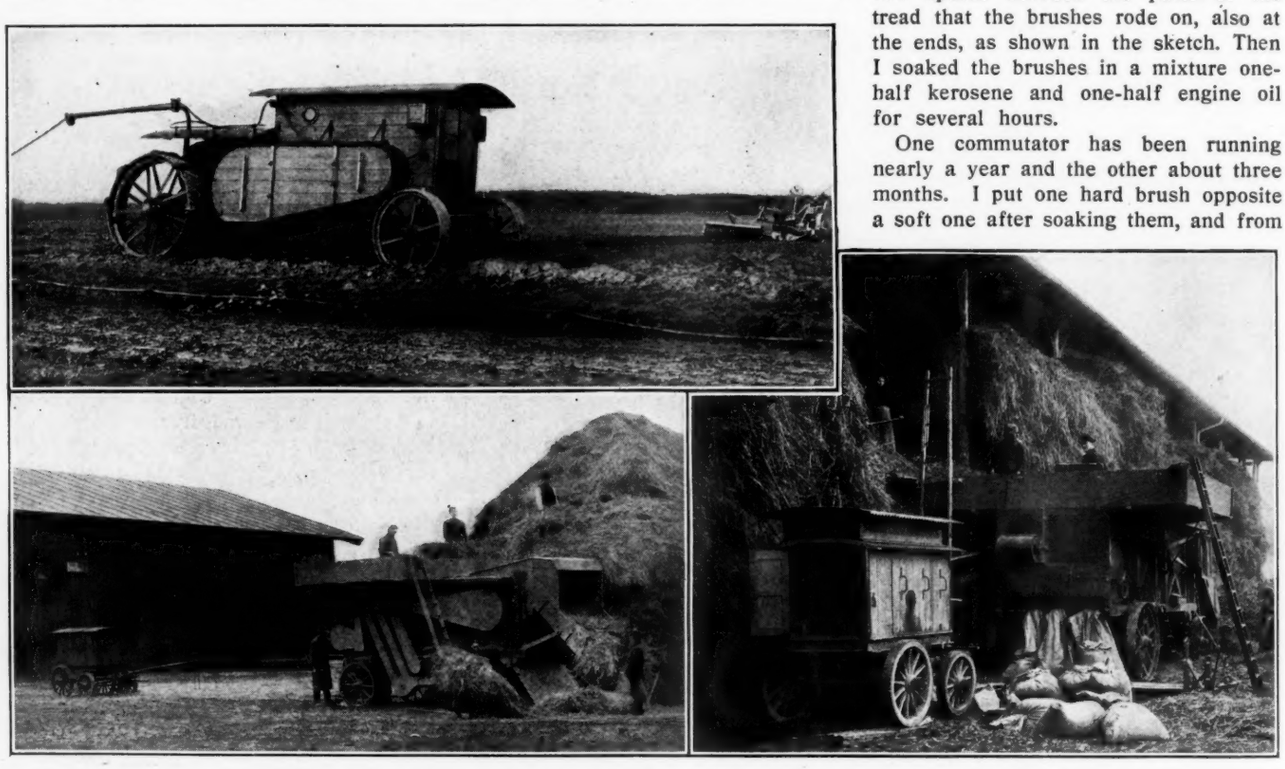
FIG. 5. HIGH-TENSION LINE CROSSING ROAD NEAR PRAUST

apparatus is also located behind the switchboard, in iron frames between massive partition walls and closed in by wire-gauze screens. The iron frames also support three-phase transformers through which current is supplied for lighting the power house and the attendants' houses.

DISTRIBUTION AND UTLIZATION

The electrical energy generated at the power house is mainly distributed by six transmission lines at the generator potential of 8000 volts. Another 8000-volt transmission line will possibly be added later. Two of the 8000-volt transmission lines run in a southward direction and are connected to form a loop. A third line, which runs eastward for a distance and then northward, is to be "tied in" with one of the two northward lines feeding the Muggau transformer station, whence two branch lines extend northward and westward respectively. In the western branch line, which supplies a considerable amount of energy for operating brick mills, the potential is raised to 15,000 volts in a 150-kv.-a. oil-cooled transformer. Excepting a section nearly 2 miles long, all the transmission lines are overhead. The main line is of hard-drawn copper wires about equal to No. 5 B. & S. gage in cross-section and the branch line wires are about equal to No. 7. The transmission lines are located about 23 ft. above the ground and are subdivided by a number of section switches. Fig. 5 shows a short stretch of one of the lines.

The high-tension current is reduced at the points of consumption to a working tension of 220 volts. As the electrical energy is supplied mainly to a number of isolated farms, the number of transformer stations is relatively large. Portable transformers with disk windings and dry insulation, which are rented out by the district management, allow those farmers possessing extensive tracts to do all their harvesting and other operations in the fields with the aid of motor-driven machinery. Some of these equipments are illustrated in the accompanying pictures, Figs. 6, 7 and 8.



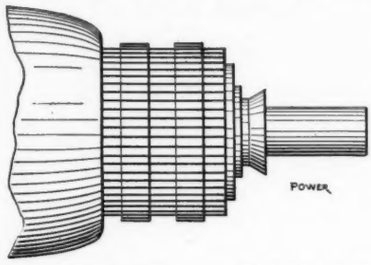
FIGS. 6, 7 AND 8. TRANSFORMER WAGONS SUPPLYING A MOTOR-DRIVEN PLOUGH AND TWO THRESHING MACHINES

LETTERS

A Kink in Undercutting

It had been the regular practice here to turn down the commutators of the exciter dynamos at least once a month, and shortly after taking charge, I had a small-sized imitation of a fourth of July celebration, when a commutator of one of the exciters burst, it having been turned down until the bars were too thin to resist centrifugal force. (I had previously notified the manager that it did not appear safe to run very long.) I tried soft and hard brushes with no better results from one than another on the commutators.

After finishing the first commutator I had to turn down, I made a small narrow tool with a nose as wide as the thickness of the mica between the bars, put it sidewise in the tool-post of the lathe, and cut the mica down about $\frac{1}{32}$ in. below the level of the bars by moving the tool carriage along; after cutting a strip I turned the armature, which was between the centers of the lathe, by hand from one space to the next, cut that down and turned the armature to the next strip, and so on until all were cut down alike. Then I turned the commutator bars down about $\frac{1}{16}$ in. in the narrow spaces between the parts of the tread that the brushes rode on, also at the ends, as shown in the sketch. Then I soaked the brushes in a mixture one-half kerosene and one-half engine oil for several hours.



MR. FRIES' FINISHED COMMUTATOR

One commutator has been running nearly a year and the other about three months. I put one hard brush opposite a soft one after soaking them, and from present indications commutator trouble is a thing of the past here.

Middleboro, Mass. J. W. FRIES.

Mr. Bates' Thawing Current

Referring to J. E. Bates' letter in the Jan. 30 issue of POWER, I think there must have been some other source of heat than the little half-ampere of current flowing through his supply pipe to the house. If he had stopped to figure a moment, he would have noticed that it took 400 times the amount of current in the first instance to thaw just three times the amount of ice. The warmth must have come through the ground—a thaw from below.

Roundup, Mont. L. EARLE BROWNE.

Gas Power Department

Worth-while gas-engine and producer information treated in a way that can be of practical use

Oil Engines in a Hungarian Municipal Power Plant

The following abstract* describes the salient features of two 300-hp. oil engines in the municipal power plant of Torda (Hungary) and presents some operating results obtained from them.

Torda is a city of about 15,000 inhabitants, situated in the State of Transylvania. For a long time the authorities had contemplated adding to the 100-hp. Diesel equipment, which at one time sufficed to supply the electric street-lighting system as well as a limited number of private consumers, and recently the load increased so far beyond the capacity of the already overloaded plant that it was decided to enlarge it at once. A new power house was accordingly built and equipped with two 300-hp. Nicholson-Litzenmayer crude-oil engines, each direct-connected to a 260-kv.-a. Siemens-Schuckert alternator designed to deliver three-phase currents at 3100 volts and 50 cycles. The old 100-hp. Diesel engine and generator were retained and modernized.

*Of a paper by Laszlo Bano, presented before the Hungarian Society of Engineers and Architects of Budapest. Translated by L. I. Oesterreicher for the Journal of the Society of Hungarian Engineers of America.

The distribution of the three-phase currents is effected by means of the usual three-wire system and step-down transformers, ranging in size from 7.5 to 30 kw., which deliver to Y-connected four-wire secondary lines; from the secondary mains current is delivered either at 210 volts between main wires for power, or at 121 volts between the neutral and one main wire for lamps. The street-lighting equipment consists of 40-cp. metallic-filament incandescent lamps, and a few arc lamps.

The power house is a one-story brick structure with a basement of 8 ft. 4 in. pitch. In the basement are four electrically driven cooling-water pumps, two of the centrifugal and two of the piston type. The pumps take the hot jacket water from the engines and deliver it to a cooling tower about 20 ft. above the engine-room floor; from here it flows by gravity to the engine-cylinder jackets and the compressed-air tank cooling coils in the basement.

The engines of the new units are twin two-cylinder, horizontal machines, with the generator mounted between the two members of the twin unit as shown in Fig. 1. Each member of the unit is complete with its own valve-gear and air compressor. The revolving field-magnet of the generator serves as a flywheel, giving a 1:180 variation. The diameter of each cylinder is 5¾ in., the stroke 22⅞ in. and the speed 187.5 r.p.m.

Adjacent cranks are set in the same position on the crankshaft and the two cranks of one member of the pair are set at 180 deg. from those of the other. There are two explosions per revolution of the crankshaft, the engine working on the four-stroke cycle. Although each cylinder has a separate valve motion, the crude-oil supply pumps of all four cylinders are arranged around the valve-motion shaft of cylinder No. 1 (the right-hand cylinder in Fig. 1) and connected to a centrifugal governor which regulates the oil supply for varying load conditions.

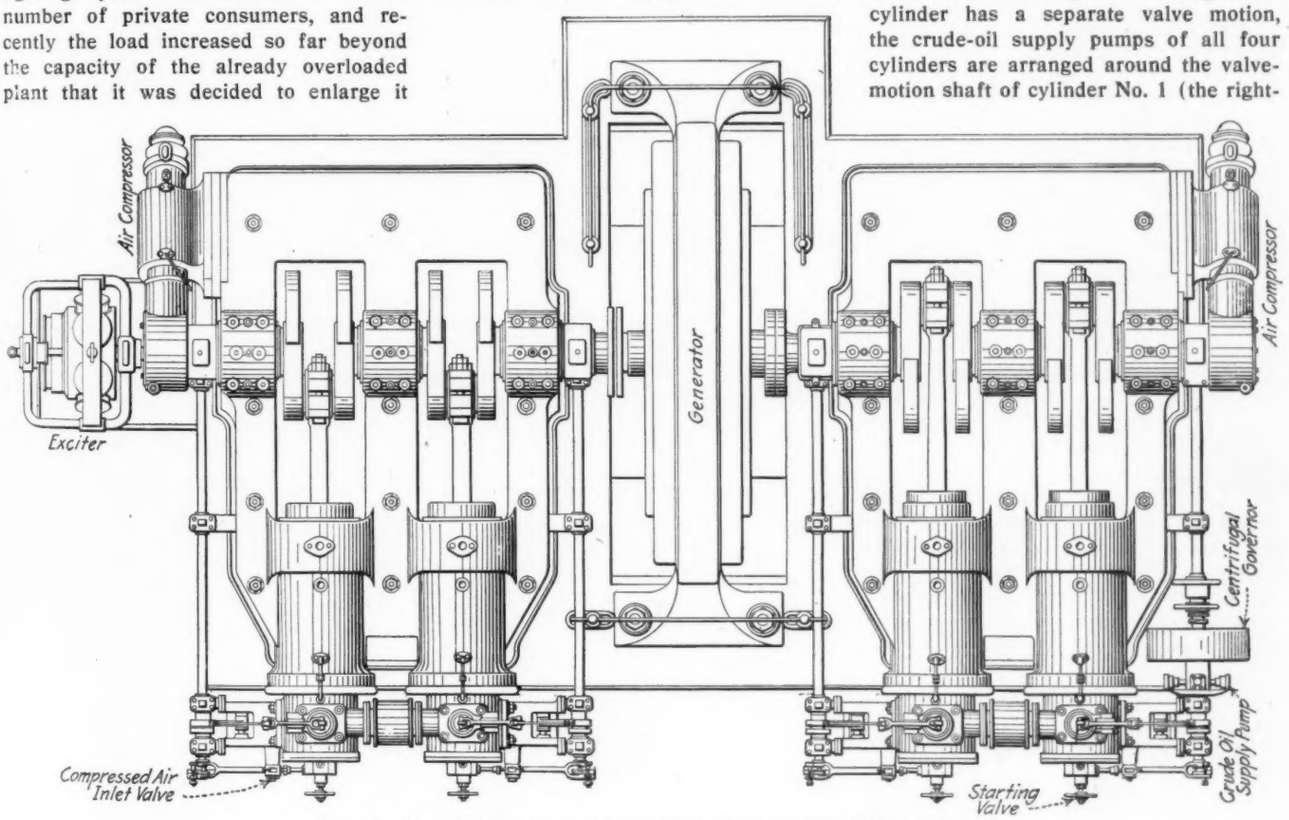


FIG. 1. PLAN VIEW OF A GENERATING UNIT IN THE TORDA PLANT

One-half of the engine bed and the outside cylinder barrels of one pair are cast in one piece. The cylinder liner fits closely into a ring at both ends of the outer barrel. A brass ring between the two barrels at the crank end makes the joints water-tight. The head-end flanges of both barrels are slightly tapered and rubber gaskets between the two tapered

metallic surfaces serve to keep the joints tight and also allow the necessary play for the expansion or contraction differences of the liner and the outer barrel. The crankshaft is made of Martin steel in two pieces, a counterbored flange coupling fastening the two halves together.

A centrifugal oiling device lubricates the crankpins and all other shaft bearings have oil-ring lubrication; the pistons are fed by automatic oil presses.

The pistons are of the long trunk type, packed by eight rings each. The cross-head pin is made of Mannesman compound cast steel with glass-hard outer working surfaces and soft cores.

The cylinder breech is a separate piece, made of cast iron, with a jacket for water cooling. On one side the breech fastens to the end of the cylinder barrel; the other side is closed by a removable cast-iron head, allowing easy and quick access to the interior.

The most important part of the engine, the air-nozzle head, is a combination of starting device, oil warmer and carbureter, and assists in igniting the charge. It projects through the center of the cylinder head. Figs. 3 and 4 show two cross-sections at 90 deg. to each other. Each cylinder is equipped with this attachment, so that the engine may be started with whichever piston is in good starting position. By turning the handwheel *C* the valve stem *D* opens the ball valve *E*, through which compressed air at 950 lb. pressure per square inch flows through passages *H* and *F* into the cylinder and starts the engine, after which the ball valve *E* is closed. During the suction stroke, one of the crude-oil pumps *M* around the lay shaft (Fig. 5) forces the necessary fuel oil through the check valve *O* into the oil-warming chamber *B*, which is in constant communication with the explosion chamber. Immediately before the dead center is reached, the valve mechanism opens the compressed-air inlet valve *G* and compressed air rushes into the chamber *B*, when the previously deposited and warmed oil becomes mixed with the inrushing air and is carried into the explosion chamber. At the end of the compression stroke, the temperature in the cylinder attains or exceeds the ignition temperature of the oil, igniting the mixture of air and oil.

The valve-motion shaft carries three cams which operate the air inlet and exhaust valve rods through rollers. Beside the cam for the compressed-air inlet valve, a higher cam controls the air supply at the start. By means of a spring pawl the air-inlet valve-rod may be shifted to either the starting or the running cam; this arrangement makes it unnecessary to provide a separate starting valve; moreover, the engine is self-starting when it stops in a favorable position with respect to the starting cam of the compressed-air inlet valve.

Another important feature of the engine is the crude-oil supply pump and its connection to the centrifugal governor. Fig. 5 shows the four pumps arranged equidistantly around the lay-shaft, which is also the governor shaft. The eccentric *J* forces the plunger pistons inward and they are returned by springs.

Within the eccentric *J* another eccentric *I* will be noticed; this second eccentric is pinned to a disk which is rotated by the centrifugal governor. Turning one eccentric within the other will change the eccentricity and correspondingly change the stroke length of the oil-pump pistons, thereby regulating the crude-oil supply to the cylinders. The governor is of the ordinary weight and spring type, and is provided with a handwheel and a small electric motor by means of which the governor spring tension can be adjusted to get the proper speed. The motor is wired for remote control from the main switchboard, giving complete speed control to the operator for synchronizing and operating the generating sets in parallel.

The necessary compressed-air supply on account of its high pressure (850 to 1050 lb. per square inch) is compressed in two stages: the first attains a pressure of 104 lb., and the air then passes through a cooler to the high-pressure cylinder, and after being compressed to the required pressure, to a second cooler whence it passes into the air tanks.

The low-pressure pistons are of cast iron and have ordinary ring packings; the high-pressure pistons, in addition to rings, have labyrinth packings. The air compressor suction valves take air from the basement, thus eliminating the rattling noise from the engine room.

The daily fuel-oil supply is stored in a small tank mounted on the outside of the building wall near the engines, and the oil flows by gravity to the four supply pumps of each unit. The bulk of the oil is stored in two large reservoirs built in the ground in the power-house yard and the supply for one day's run is pumped into the smaller feed tank each day.

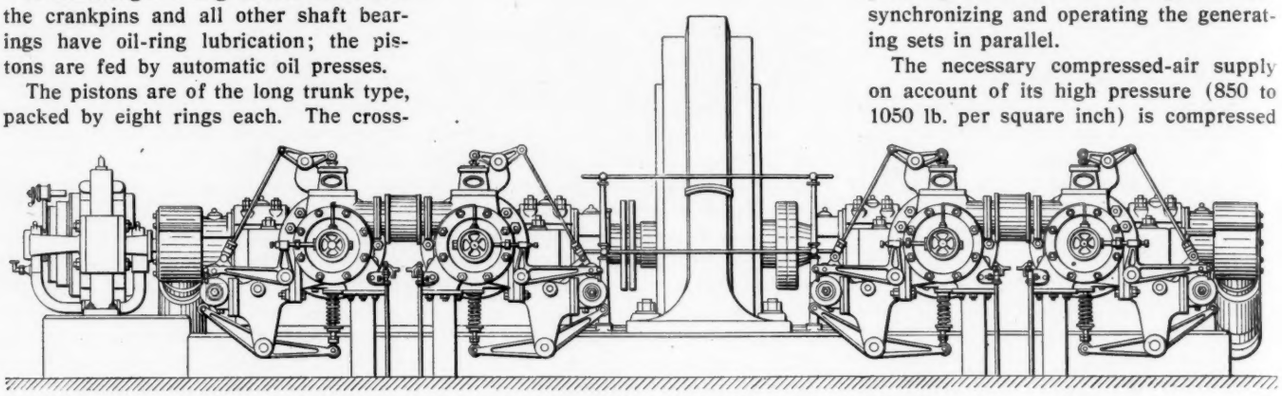


FIG. 2. BREECH-END VIEW OF A TORDA GENERATING UNIT

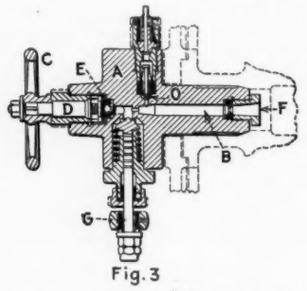


Fig. 3

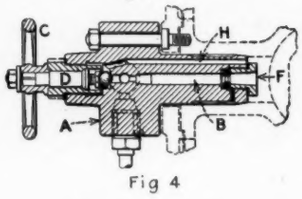


Fig 4

INLET VALVES

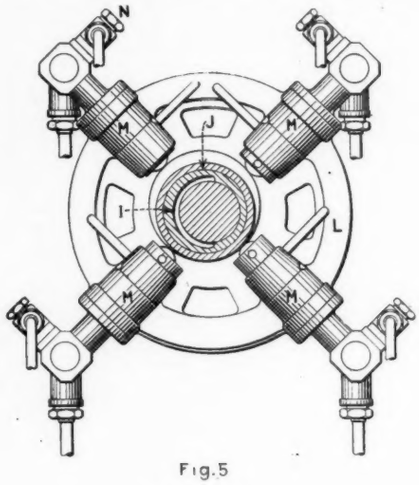


Fig.5

OIL PUMPS

Engine Performance

The fuel consumption per kilowatt-hour, measured at the switchboard, was guaranteed not to exceed the following rates:

At full load, 0.628 lb.; with 10% mixture, 0.690 lb.
At ¾ load, 0.716 lb.; with 10% mixture, 0.767 lb.
At ½ load, 0.870 lb.; with 10% mixture, 0.957 lb.
At ¼ load, 1.135 lb.; with 10% mixture, 1.248 lb.

An official test was carried out under the supervision of a number of disinterested engineers; the results are given in the accompanying table. The price of 100 kg. of crude oil delivered to the power plant is 7 crowns, and assuming that the specific gravity of the oil is 0.88, the cost per U. S. gallon would be 2.4c.

According to the test results the cost of fuel per kilowatt-hour at full load delivered at the switchboard would be 0.4c. and at one-half load, 0.5c. The price per brake horsepower-hour at full load would be 0.268c., and at one-half load, 0.3c. After an eight hours' continuous run, during seven of which the engines were under full load, the temperature was taken at different points on the engines and generators, and it was found that the temperature of the seemingly hottest crankpin was 89.6 deg. F., or 19.6 deg. above the engine-room temperature. The maximum generator temperature was 113 deg., or 43 deg. above the room temperature.

The cost of the power plant and equipment was as follows:

Oil engines, generator and entire engine-room equipment	$106,644.00
Power-house building	22,347.50
Alterations to Diesel engine	2,600.00
Total	$131,591.50

Although owned by the city, the plant is entirely free from the cumbersome, old-fashioned city administration. There are three directors, presided over by the mayor, and a general manager, who is a professional engineer, has full charge of the plant and is responsible to the directors for its proper operation.

Electric energy is sold to small lighting consumers at 14c. per kilowatt-hour with a sliding-scale reduction according to the monthly energy consumption. For power purposes, energy is sold at 0.6c. per kilowatt-hour, with reductions to large consumers. A renting fee is charged for the wattmeters, ranging from 10c. per month for the small meters up to 60c. for the larger ones.

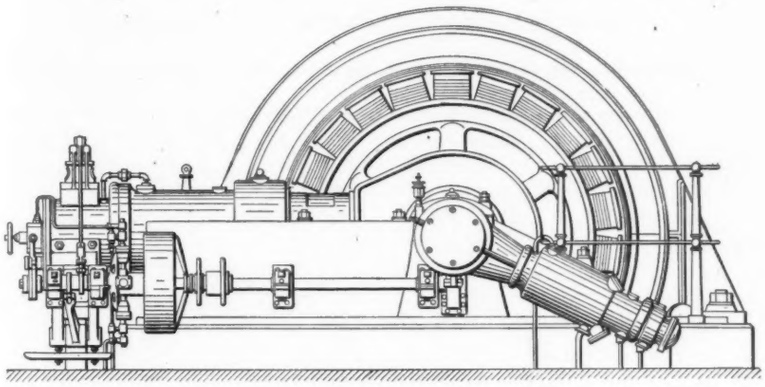


Fig. 6. View of Torda Engine on Governor Side

TEST RESULTS

Oil engine	131–134	127–130
Generator	7,451	7,452
Duration of test	4 hours	6 hours
Net output; average kilowatts, by hourly wattmeter readings	198.7	189.1
Kilowatts absorbed by exciter	3.85	4.7
Total average output, including exciter	202.55	193.8
Voltage, mean hourly	2,875	2,881
Current, mean hourly	41	38.25
Revolutions per minute, mean	186.8	187
Average engine horsepower, indicated	441.63	418.85
No-load engine, horsepower indicated	120.08	120.08
Average engine, brake horsepower	321.55	298.77
Average electrical horsepower	266.50	253.60
Heat value of crude oil, approx	18,037 B.t.u.	18,037 B.t.u.
Total oil consumption per hour	131.285 lb.	127.534 lb.
Oil consumption per kilowatt-hour	0.66	0.675
Oil consumption per brake horsepower-hour	0.408	0.427
Oil consumption, indicated horsepower-hour	0.297	0.304
Mechanical efficiency of engine	72.8%	71.3%
Mech. and elec. eff. of engine-generator unit	60.3%	60.5%
Thermal efficiency with respect to indicated horsepower	47.5%	46.3%
Thermal efficiency in regard of brake horsepower output	34.5%	33.0%
Temperature of jacket cooling water (inlet)	59° F.	59° F.
Temperature of jacket cooling water (discharge)	98.6 to 107 deg. F.	104 to 120 deg. F.
Temperature of exhaust gases	509 to 644 deg. F.	554 to 688 deg. F.

CORRESPONDENCE

Care of Exhaust Valve Stems

J. W. Fries' article in the Mar. 12 issue of Power is of a great deal of practical value; he describes an easy means of meeting a condition that nearly every operator of internal-combustion engines will be confronted with sooner or later.

As soon as there is sufficient wear of either the valve stem or the guide for even a slight leakage of exhaust gas, it becomes nearly impossible to lubricate the stem because the extreme heat of the exhaust gas burns the oil, especially if the stem is not water-cooled.

My experience has been similar to that of Mr. Fries excepting that the valves and stems were not water-cooled, and that I bushed the guides instead of "sleeving" the stems.

The old stems were an inch in diameter, so I had new stems turned up from 1⅛-in. mild steel. These were driven into the valve heads and headed over on the opposite side.

Then I had the guides bored out to 1½ in. diameter, and put in brass bushings bored out to fit the stems except for a distance of about 1 in. near the center of the bushing, where the bore is made about ¼ in. oversize, leaving an annular pocket all the way around the stem, for holding a lubricant. A hole through the side leads to this pocket and I fill it with grease under pressure.

I keep extra bushings on hand and it is only a short job to drive out a worn one and replace it with a new one.

Earl Pagett.

Coffeyville, Kan.

Testing a Small Gas Engine with a Prony Brake

A simple prony-brake test of a 3-hp. gas engine brought out a feature of brake testing that might be helpful to some of the readers of Power.

The test was run on a single-cylinder engine having a flywheel 14 in. in diameter and designed to deliver 3 hp. at 650 r.p.m., working on the two-stroke cycle. The prony brake was a heavy home-made wooden affair having a lever arm 2 ft. long and a bearing surface of about 20 sq.in. Water was used for cooling. When the engine was running free it turned up about 830 r.p.m.

The brake was screwed up until a torque of 20 foot-pounds was registered and the speed was 700 r.p.m. So far so good; but when an additional twist, however small, was given to the thumbnut the brake seized tight, stopping the engine short. This happened several times, and then it was suggested that oil should be used in place of water. This was done, with the result that the brake could be tightened down to obtain almost any speed within the limits of 400 and 830 r.p.m. The maximum horsepower, 3.2, was developed at about 670 r.p.m.

It seemed that the brake was so heavy and powerful that its efficiency as a brake had to be reduced by using oil before it could be practical for measuring such small power. In general, a brake should be as light as possible to stand the torque, and a fine-pitch tightening screw should be used to put the load on gradually.

Alan A. Slade.

Providence, R. I.

Heating and Ventilation

Considered as power-plant problems. Layout and operation of systems and apparatus

Piping a Dry Kiln

By W. H. Wakeman

Inasmuch as some of the dry kilns found in service are not piped according to approved designs, Fig. 1 is presented to illustrate several valuable points in this connection. It is proposed to take steam at 15 lb. pressure from a 40-hp. tubular boiler and heat a kiln about 200 ft. distant. This kiln contains about 5000 ft. of 1¼-in. pipe, laid in sections below the floor line, and the heating pipes pitch toward the boiler.

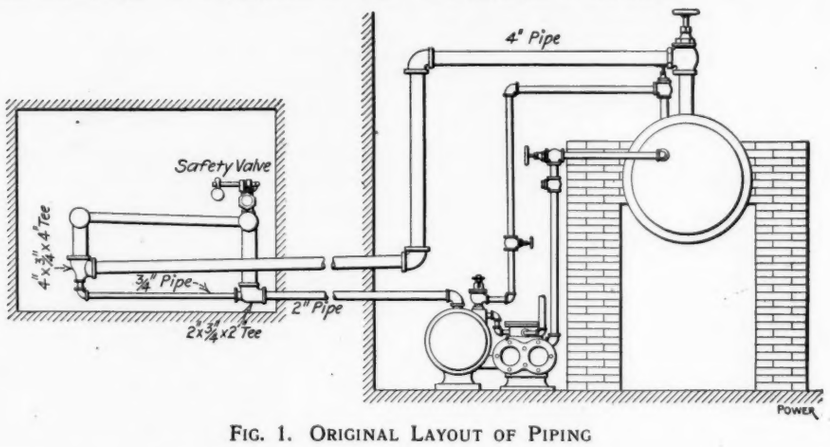


Fig. 1. Original Layout of Piping

As the pressure is light, the supply pipe must be large accordingly; hence 4-in. pipe should be used. Steam will be turned on and shut off by an angle valve, with the stem set vertically as shown. Sometimes a safety valve is located here, with a globe valve beyond it, but it is much better to have a separate outlet for surplus steam. While the kiln is in service two outlets are then available to prevent overpressure, but the safety valve ought to be large enough to constitute what its name implies. A 3-in. pop or a 4-in. lever valve will be sufficient.

The main steam pipe should pitch from the boiler throughout its entire length (except a short vertical piece) and the nearly horizontal part terminates in a 4x¾x4-in. tee. The ¾-in. outlet is necessary to drain the main pipe, as otherwise water will collect at this point and prevent a free flow of steam. As this pipe is connected directly into the main return pipe, it appears as if steam might flow directly back without going through the heating pipes, but it is too small to do more than provide a hot drip pipe, which is necessary to prevent water-hammer.

Water of condensation flows through the heating pipes into the return header, which is relieved of surplus pressure by a 2-in. pop, or a 2½-in. lever safety valve. This water falls into a 2x¾x2-in. tee and thence flows to a receiver, from which it is taken by a duplex pump and returned to the boiler.

As the available steam pressure is light, this service calls for a low-steam pump, with a steam piston about 6 in., a water piston about 2 in. in diameter, and a stroke of 6 in. or the equivalent of this design. The exhaust steam from this pump must be wasted, as it cannot be discharged into the heating system against full pressure.

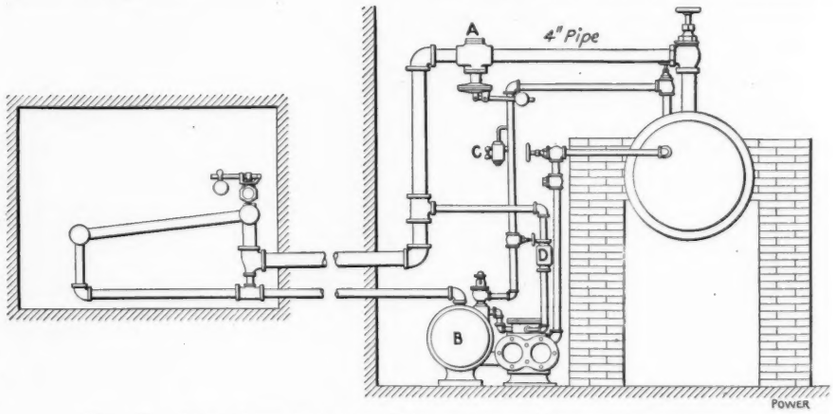


Fig. 2. New Arrangement Which Gave Better Satisfaction

Fig. 2 illustrates an improved piping system for the same plant, provided about 40 lb. pressure can be carried on the boiler. A reducing valve is shown at *A*, which lowers the pressure to 10 lb. The heating pipes pitch from the boiler; hence the nearly horizontal steam pipe terminates in a 4x¾x4-in. tee as before, but the ¾-in. drip pipe discharges directly into a 2x2x¾-in. tee. The entire return pipe is 2 in. in diameter and it discharges into a receiver *B*, from which it is taken by a duplex pump and returned to the boiler. As a higher pressure is available in this case, an ordinary pump can be used; size 5x3x5 in. will be sufficient. A sight-feed lubricator is shown at *C* and the separator *D* removes all oil from the exhaust steam. This can now be discharged into the heating system, thus preventing all loss of heat from this cause.

Steam Heating of Large Department Stores

By Henry D. Jackson

In the Feb. 27 issue, Davis S. Boyden gave some interesting figures on the cost of heating department stores. His figures, however, are entirely from the central-station standpoint; and while his article leads to the belief that it was far cheaper to heat the building as indicated and purchase the electrical power necessary, it is doubtful if such is the fact if we use Mr. Boyden's own figures for the coal required for furnishing this power.

The figures given in Table 4, on page 302, make it possible to figure the total cost for electric power, which amounts to $53,876.31, or approximately 1.94c. per kilowatt-hour. This, as may be noticed, is a low price for electric power generated in a central station.

In the article Mr. Boyden states that the coal which would be required in an isolated plant to generate the electric power for this building would be 694

tons. A considerable portion of this would be available for heating, so that this total coal would not only represent that required for electric power, but, if the plant were properly operated, it would be available to some extent for heating purposes. With coal at $3 a ton, this would represent $20,823.

There is already in the plant 750 hp. in boiler capacity. The total boiler capacity required if 1500 kw. of generator capacity was installed, would not exceed 1250 hp., as boilers under the present rating can readily be crowded to give nearly double their rated capacity when occasion requires; therefore it would be easy to have one spare boiler with 1250 boiler horsepower installed in units of 250 hp. each. Then the total capacity of the plant would be 1500 kw., which would be ample for the purp

Mr. Boyden figures out the yearly load factor on this plant to be 9.3 per cent., and it is interesting to notice that the central station which furnishes power to this company has a ratio of the average consumption to the total connected load of but 9.9 per cent., which nearly approximates the same condition that he claims holds in the isolated plant. As the central station has absolutely no means of obtaining profit, or, what amounts to the same thing, of reducing the cost by the use of the exhaust steam, this ratio means far greater losses in the central station than it does in the isolated plant.

A plant of this type should not cost over $90,000; the building and the stack are already there and are required for other purposes than the generating plant. Taking the maintenance, depreciation, etc., at 12 per cent. would give a fixed charge of $10,800. Allowing a reasonable increase in the amount of labor would make the total cost for labor $6000; water, $1300; supplies, etc., $1500, making a total cost for heating and electric power of $40,423, or a saving of approximately $15,453 over the purchasing of power alone, in accordance with Mr. Boyden's figures, and it is to be noted that no fixed charges are made upon the heating plant, so that the actual saving would be considerably greater. In these figures it has been assumed that Mr. Boyden is correct when he says that it will take 5 lb. of coal per kilowatt-hour. I do not believe that a similar plant would need anything like 5 lb. per kilowatt-hour. While light is required practically day and night, the amount for the latter is comparatively small. This, however, would readily be taken care of without a material waste of coal if the generating units were properly proportioned, and under the conditions of a heating system properly arranged, the back pressure should be negligible; therefore, 4 lb. of coal per kilowatt-hour should be ample for all purposes, and would reduce the coal cost to $16,700, or the total cost to $36,323, including fixed charges.

As the plant now operates, the heating cost is $8582.29 and the electric power costs $53,876.31, making a total cost of $62,458.60. This makes a saving of $26,135.60, neglecting the interest, maintenance and depreciation charges on the heating plant which would materially increase the saving.

Fig. 3 of Mr. Boyden's article is decidedly interesting to the illuminating engineer. According to the curve of kilowatts of electrical energy supplied, it might be imagined that there were no windows at all in this building, as the load comes on shortly after 8, rises very rapidly until 9, gradually increases until 5, and then rapidly drops off; in other words, the effect of the increasing light due to the rising sun or to the increasing daylight has absolutely no effect in reducing the amount of power required. This condition of affiairs is hardly consistent with that in most establishments, for as the day brightens, it would be natural for the electrical energy required for light to diminish.

As a matter of fact, these buildings get light from two sides, have very large window surfaces, and should be fairly well lighted during daylight hours. It might be thought that Mr. Boyden's curve is one taken from a dark, gloomy day rather than from a typical, clear winter day. If not, the building manager is decidedly remiss in that he apparently does not reduce the amount of light used artificially in accordance with the amount of light available from outside sources.

It is also interesting to notice that if the cost of heating as given in Mr. Boyden's paper is subtracted from the total cost of heating and electric power, as it would be in the case of an isolated plant, the cost of electric power per kilowatt-hour would be approximately 1c. as against 1.94c. as purchased.

In the *Isolated Plant* for April appears an article criticizing Mr. Boyden's paper. In the course of the article it is stated that if an isolated plant had been installed the fuel bill per year would amount to $25,000.

Mr. Boyden states that $5718 was spent for 1920 tons of fuel, almost exactly $3 per ton. The total kilowatt-hours are given as 2,776,370, and the evaporation from and at 212 deg. as 9.3 lb. of water per pound of coal. Dividing $25,000 by 3 would give 8333 tons of coal, and at 2000 lb. per ton this would mean:

$$\frac{8333 \times 2000}{2{,}776{,}370} = 6 \text{ lb.}$$

per kilowatt-hour in fuel, disregarding the heating for the time being. What kind of an engine as large as 500 kw. would show such a poor performance? Mr. Boyden himself only allows 5 lb. of coal per kilowatt-hour, and surely no one should accuse him of being mean from his standpoint and interest.

There would be only about 176 tons of coal required for live-steam heating under the worst conditions, and a large portion of the 200 tons allowed for kitchen and hot-water service would be heated by exhaust steam in the case of an isolated plant being installed.

If 93 lb. of steam are generated per pound of fuel from and at 212 deg. F., the steam consumption per kilowatt-hour at the switchboard would amount to nearly 56 lb. This would be equivalent to 42 lb. of steam per brake horsepower-hour which is well within the range of an old-fashioned slide-valve engine.

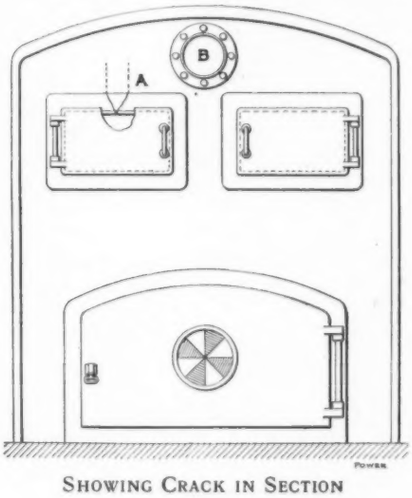
IRA N. EVANS.

New York City.

A Temporary Repair

A low-pressure steam-heater section became checked or cracked as shown in the drawing at *A*. It leaked so badly that it became necessary to provide some means of repair so that steam could be maintained. A new section was ordered from the factory, but a delay of two to three weeks was necessary. The heater was needed more or less until the new section came, so the following method was adopted:

The section was taken out from the setting, and the crack scraped with an



SHOWING CRACK IN SECTION

old file until a crevice $\frac{1}{16}$ in. deep was found. It was scraped on the inside as well as the outside as it could be got at through the steam hole *B*. The crevices were washed with acid, rinsed with water and filled with the following paste: Smooth-On, sal ammoniac and water. This paste was worked in well and left to stand for 24 hours. The section was put back in place and has been working under a pressure of 8 lb. for five or six weeks.

J. HUG.

Ames, Iowa.

Steam Power Plants

The January *Proceedings* of the Engineers' Society of Western Pennsylvania contains a very interesting paper on "Steam Power Plants," by O. S. Lyford* and R. W. Stovel,† which was read at the December meeting of that society.

Owing to the breadth of the subject the paper was confined to steam-turbine plants using bituminous coal for fuel. Ten plants of this character were selected ranging in capacity from 79,000 down to 1000 kw., and the considerations affecting their design together with cost data are taken up.

Referring to Table 1, which shows the probable limits of cost of stations belonging to the class referred to, some of the costs apparently do not have any specific relation to the capacity installed and the probable range in such costs is a matter of previous experience. This refers to such items as "preparing site," "yard work" (such as condensing water flumes, etc.) and "service equipment."

It was pointed out that the foundation costs would range from $1.25 to $4 per square foot of building-plan area, depending upon the character of the soil. The lower figure would cover simple concrete footings or good bearing soil while the necessity for piling, waterproofing, excessive rock excavation, etc., would bring the cost near the higher figure. The plan area will average from 0.8 to 1.5 sq.ft. for each kilowatt of capacity installed, depending upon the size and arrangement of the units.

The building costs will vary from 8 to 12c. per cubic foot of building volume, and there will be required from 50 to 100 cu.ft. of volume per kilowatt of capacity, making from $4 to $12 per kilowatt.

The boiler-room equipment costs are shown in Table 2. These represent labor and material only and do not include any general charges such as engineering or supervision. The unit costs in Table 2 relate to rated boiler horsepower, whereas those in Table 1 are based upon kilowatts capacity of the generators. These costs, however, generally vary directly with the rating of the boilers regardless of how much boiler capacity may be installed to serve a given generator capacity.

In regard to economizers, the authors state that: "With 50 per cent. annual load factor and coal costing $3 or more per ton, the saving with economizers is enough to more than cover their fixed charges and maintenance. These conditions may vary 20 per cent. and the economizers still show an annual saving. When the coal costs less than $3 per ton economizers are seldom justified by heat economy only, although they may be justified from the standpoint of heat storage. With a rapidly fluctuating load, they aid the boilers in meeting sudden demands."

As to the selection of condensers, it is the authors' opinion that since surface condensers will cost from $1 to $3 more per kilowatt than the mixing type, their use must be well justified. Since there is now little difference in the amount of vacuum which either type may be depended upon to produce, the selection is governed almost wholly by the condensing water supply. If this water is suitable for boiler feed there is usually no good reason for the surface type. In general, it is assumed that if the cost of feed water does not exceed 6c. per thousand gallons, and if the average load on the plant does not exceed one-half the maximum load, then surface condensers are not warranted.

Table 3 gives a summary of operating results based on common practice where bituminous coal of about 14,000 B.t.u. per pound is used.

TABLE 1. COST OF STEAM TURBO-ELECTRIC GENERATING STATIONS FROM 2000 TO 20,000-KW. CAPACITY, BASED ON MAXIMUM CONTINUOUS CAPACITY OF GENERATORS AT 50 DEG. RISE.

	Dollars per kilowatt High	Low
Preparing Site—Dismantling and removing structures from site, making construction roads, tracks, etc.	$0.25	....
Yard Work—Intake and discharge flumes for condensing water, railway siding, grading, fencing, sidewalks, etc.	2.50	$1.00
Foundations — Including foundations for buildings, stacks and machinery, together with excavation, piling, waterproofing, etc.	6.00	1.00
Building — Including frames, walls, floors, windows and doors, coal bunker, etc., but exclusive of foundations, heating, plumbing and lighting	12.00	4.00
Boiler-room Equipment—Including boilers, stokers, flues, stacks, feed pumps, feed-water heater, economizers, mechanical draft and all piping and pipe covering for entire station except condenser water piping	24.00	12.00
Turbine-room Equipment—Including steam turbines and generators, condensers with condenser auxiliaries and condensing-water piping, also oiling system, etc.	22.00	12.00
Electrical Switching Equipment — Including exciters of all kinds, masonry switch structure with all switchboards, switches, instruments, etc., and all wiring, except for building lighting	5.00	2.00
Service Equipment—Such as cranes, lighting, heating, plumbing, fire protection, compressed air, furniture, permanent tools, coal and ash-handling machinery, etc.	5.00	2.50
Starting Up—Labor, fuel and supplies for getting plant ready to carry useful load	1.00	0.50
General Charges—Such as engineering, purchasing, supervision, clerical work, supplies, watchmen, cleaning up, etc.	6.00	3.00
Total cost of plant to owner, except land and interest during construction	$83.75	$38.00

TABLE 2. BOILER-ROOM EQUIPMENT COSTS PER RATED BOILER HORSEPOWER

	Dollars per horsepower High	Low
Boilers, exclusive of masonry setting	$11.00	$8.00
Superheaters	3.00	....
Stokers	5.50	3.00
Masonry setting for boilers	3.50	2.00
Flues	1.50	0.75
Stacks	4.00	2.00
Economizers	4.00	....
Mechanical draft	3.00	....
Feed pumps	1.50	0.50
Feed heaters	1.00	0.40
All piping and pipe covering	10.00	6.00
Coal chutes and ash hoppers	1.25	....
Various items, such as indicating and recording meters, damper regulator, ladders and runways, painting, etc.	1.00	0.50
Totals	$50.25	$23.15

TABLE 3. SUMMARY OF OPERATING RESULTS

	Range of practice	
B.t.u. per pound of fuel	14,000	....
Average yearly overall boiler and furnace efficiency	50	70
Effective B.t.u. per pound of fuel	7,000	9,800
Boiler pressure, pounds per square inch, gage	125	190
Superheat, degrees Fahrenheit	....	125
Average feed-water temperature, degrees Fahrenheit	120	200
B.t.u. per pound of steam (approximate)	1,100	1,100
Pounds of water evaporated per pound of fuel (actual)	6.36	8.91
Pounds of fuel per standard boiler horsepower	4.76	3.40
Average overall station water rate per kilowatt-hour	30	20
Pounds of coal per kilowatt-hour generated	4.72	2.25
B.t.u. in coal per kilowatt-hour generated	66,000	51,500
Thermal efficiency of station, per cent	5.2	10.8

*Consulting engineer, with Westinghouse, Church, Kerr & Co.

†Mechanical engineer, with Westinghouse, Church, Kerr & Co.

Long Distance Transmission Record

What appears to be the world's record in long-distance transmission was attained on Apr. 1, when the dynamos at the Great Falls (N. C.) plant of the Southern Power Co. sent high-tension current over a circuit of 330 miles. This was accomplished when the test of connecting the lines of the Southern Power Co. with the wires of the Yadkin River Power Co. on an interchange basis was made. From the Great Falls plant on the Catawba River the power was transmitted over the lines of the company to Durham and thence to Raleigh.

"I've been going a pretty swift pace for years," said the flywheel.

"Yes, and you'd have been broke long ago if it wasn't for me," replied the governor.

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POWER

Steam in Gas Producers

Though it is true that the introduction of steam into a gas producer has been proved by actual experience to be necessary for practical operation, it is theoretically a doubtful practice. There are three reasons for adding steam to the blast of a gas producer: to lower the temperature of the fuel bed and thereby prevent the fusion of the ash, resulting in the formation of clinkers; to reduce the loss of heat in the gas leaving the producer, and to prevent destruction of the walls of the generator by fusion with the ash.

By reducing the temperature of the fuel bed the formation of CO from CO_2 and C is retarded and consequently the capacity of the producer is lowered. The introduction of a dry blast enhances the production of CO and lowers the amount of CO_2. Results of tests have further shown that the higher the temperature of the fuel bed, within practical limits, the better will be the quality of the gas. The reduction of the heat losses in the gases leaving the producer, due to the addition of steam to the blast, is brought about by certain reactions that absorb a part of the energy which would otherwise leave the producer in the form of sensible heat in the gases. These reactions make available this energy for use in the gas engine or for heating purposes and tend to increase the efficiency of the plant. The high percentage of CO_2, however, which results from the introduction of relatively large quantities of steam makes it debatable whether a real gain in efficiency is accomplished.

It is well known that the use of an excessive amount of steam impairs both the quality of the gas and the capacity of the producer. On the other hand, an insufficient amount is, perhaps, almost as bad and will result in added expense for the removal of clinkers, cleaning and frequent renewals of the brick lining.

The right proportion of steam to air must be determined for each individual installation and, although certain percentages have been established in a general way, local conditions such as the type of generator, the character of the coal, the relation between the generator capacity and the gas requirements, etc., enter into the problem to such an extent as to be determining factors. For example, a larger proportion of steam is required to gasify coal that has a high percentage of ash of a low fusing point, in order to keep the temperature of the fuel bed down and prevent clinkering. Again, if the capacity of the producer is ample for the gas requirements and it is not necessary to push it to its maximum capacity, then the supply of steam may be sufficiently large to insure a longer life for the brick lining. In all cases, the proportion should be regulated to suit the operation of the producer and the amount of blast used.

Explosions of Second Hand Boilers

Of the numerous recent boiler explosions, not one to our knowledge has occurred in a modern power plant. Boilers used at sawmills, small refrigerating plants and for farm work have led the list and when their age and the usage they have received are taken into consideration, the reason is evident. They are old and worn out.

Men well versed in boiler principles agree that these explosions are due to weak parts which cannot withstand the stress brought upon them and that faulty design or carelessness is the cause of this weakness. But notwithstanding this, well designed boilers, and boilers where careless operation has not been a factor, do explode.

There are boilers which in some localities are not considered well designed that have been in operation a quarter of a century or more, and they are still in use. Most of them are made with single-riveted lap joints and the majority of them have been more or less abused.

In many instances, such boilers are not discarded until the demand for

greater boiler capacity forces them out; then they find their way to some quarry, sawmill, or the like, where they usually end their career by exploding.

In most states there is no law prohibiting old, discarded boilers from being sold and again put into operation, nor is there a law that will hold the owner for manslaughter or any other kind of homicide when his old, second-hand boiler explodes and kills several ignorant, unsuspecting workmen.

Although the American Boiler Manufacturers' Association is making commendable efforts to reduce boiler explosions to a minimum by adopting uniform boiler specifications, these efforts cannot effect the safety of the boilers now in operation. In after years boilers which are built under uniform specifications will be safer for a longer period, but if they are allowed to be sold and set up for use after once being discarded, there will be as many boiler explosions at sawmills and other similar plants as at present.

When state laws are enacted prohibiting the use of old and unsafe boilers, the number of explosions will be reduced, but if men are allowed to jeopardize human lives by installing old boilers just because they can be bought cheap, the rate of boiler tragedies will continue undiminished.

Protection from such occurrences demands the enactment of a law prohibiting the practice indicated and prescribing an adequate punishment for the owner who violates it.

Power Plant Operating Costs

It seems to be the exception rather than the rule to give any credit to the steam or power plant for the product it supplies to the rest of the factory. It is lamentable that such a condition obtains because it not only militates against the most economical operation of the power plant itself but also has a tendency toward the extragavant use of its product.

This does not apply, of course, to the larger establishments, as street-railway or electric-light and power plants, but there are innumerable smaller concerns all over the country where very little, if anything, is known of the actual cost of producing power, to say nothing of its economical generation and distribution. No matter whether the power distributed be in the form of steam, electricity, compressed air, hydraulic pressure, heat or any other, it is essentially a product of the department whence it comes and should be so considered, thereby giving due credit to the department producing it. This procedure is followed in all of the other departments, and in manufacturing establishments having more than one department of a similar character a keen rivalry often springs up as to which can produce the greatest volume or tonnage at the lowest cost. Although in most plants there is usually but one power house, so that there will be no possibility of rivalry, nevertheless these facts show that the power house is to some extent discriminated against.

The power plant, and everything connected with it, is not only deprived of any credit for the successful operation of the entire works, but it is often placed in the category of so called necessary evils. When everything runs smoothly and an ample supply of steam or other form of power is available, it is given no thought whatever, but as soon as something happens to entirely cut off or diminish this supply a complaint is immediately made regardless of the primary cause of the trouble, which can very often be traced back to the manager or superintendent who, perhaps, has failed to order some spare part or has refused to accede to the request of his engineer for some improvement or needed repairs to his machinery. In this case, the engineer is in no way responsible and should not be blamed. The lesson taught by such an experience, however, should be well learned and of profit.

The engineer can do considerable toward eliminating troubles in his department by doing his best with the equipment at hand, and if he shows proper willingness and ability he can often prevail upon his superior to grant at least the more modest of his requests. For example, he should make some effort at determining as closely as possible the cost of the power developed even if he has no measuring devices, such as coal weighers, water meters, etc., at his command. He can usually make a fairly accurate estimate of the amount of coal burned through a certain period and he can roughly get at the amount of water evaporated by figuring his feed-pump displacement. While such methods are crude, nevertheless the results obtained will be better than none at all because, by following the same method from week to week, his results will answer at least for comparative purposes, and with such figures as a basis for his arguments he has a much better chance of convincing the manager wherein he can reduce costs provided he is given the equipment requested.

He should also endeavor to determine the amount of power distributed to the various departments and make a charge for it at a fixed rate per unit of power. If he is not permitted to make a charge, he should keep a monthly record of it for his own information and because it might possibly be of use at some future time. There are several ways of arriving at a basis for such charges, but, to a large extent, it will be determined by local conditions. For example, power may be charged for at the same rate as if bought from a central station or at that which could be obtained if it were sold outside of the plant, or it can be fixed arbitrarily; the difference between this rate and the actual cost of production will determine the profit or loss, as the case may be, for the power station. If these things can be put down on paper with some degree of accuracy, there can be very little doubt but that benefits will result in proportion to the comparative relation between the plant in question and the ideal one.

The Rhode Island coal mine has been shut down just at a time when, in view of the general coal strike, its output would have been most in demand. There is no doubt that there is a large carboniferous deposit at this point, and that some use will be found for it in the industrial world. It is to be hoped that the investment, which this latest attempt to make it available has involved, may not be entirely lost.

It is said that from eight to ten thousand young men are annually enlisting in the ranks of the electric-light and power industry. Good old Opportunity will soon be working overtime if he is expected to provide a rising chance for this multitude.

Butt Joint Boiler Explodes at Salisbury, Md.

By F. A. Grier, Jr.

Salisbury, Md., was the scene of a boiler explosion which occurred Friday, Apr. 5, at 7:15 a.m., when one of two return-tubular boilers located in the No. 1 plant of the Salisbury Ice Co. exploded. The boilers supplied steam for two ammonia compressors, hoisting engines, private electric plant, etc. The exploded boiler, which was built about eight years ago, was 60 in. in diameter by 16 ft. long, having fifty-eight 3½-in. tubes. The shell was made of ⅜-in. steel, the heads being ½ in. thick. The boiler was tested last summer, and upon examination after the explosion it was found to be badly pitted and about 6 in. below the water line the shell was not more than $\frac{1}{16}$ in. thick in several places. About 90 lb. steam pressure was carried.

From the illustrations it may be noticed that the boiler has a butt-strap longitudinal joint. It is very seldom that a boiler with this type of joint explodes, and particularly one only eight years old. The girth seam, which, as usual, was a lap joint single-riveted, was apparently the initial point of failure. The boiler pulled in two and as may be seen in the photographs, the rivets pulled through the metal, which was greatly weakened from the pitting and corrosion previously mentioned.

The tubes were beaded on either end, and only eight were left in the head, as shown in Fig. 3. The other tubes were scattered in all directions at a distance of more than 200 yd. One-half of the boiler was carried 100 yd. and crashed

Fig. 1. Ruins of Boiler Explosion in Ice Plant at Salisbury

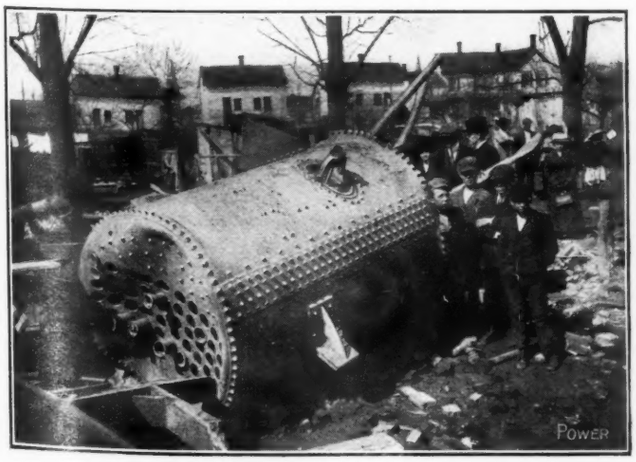


Fig. 2. Notice the Rivet Holes at the Girth Seam

Fig. 3. Eight Tubes Left in Rear Head

through the roof of and completely wrecked the stables of the Standard Oil Co., as shown in Fig. 4. The yoke to which the safety valves were attached was blown 75 yd. and was driven through the side of a grocery store, as can be seen in Fig. 5. One front furnace door weighing at least 300 lb. was blown directly across the street through a school-building window, tearing the stove in pieces and knocking down several desks.

The engineer and fireman, who had just gone to work at 7 a.m. were both killed instantly. A small boy was struck by a flying brick and had his leg broken; a minister who was attending the Methodist conference (which was in session, and being held in Salisbury) was struck by some part of the débris (perhaps a boiler tube as it landed less than 30 ft. from the church), and he was seriously injured.

The plant took fire immediately after the explosion and burned fiercely for about an hour, making the rescuing of the injured difficult. The loss is estimated at about $5000 as there was no insurance. This is the second boiler explosion in this county within 10 days, the other being a sawmill boiler, killing six and injuring three.

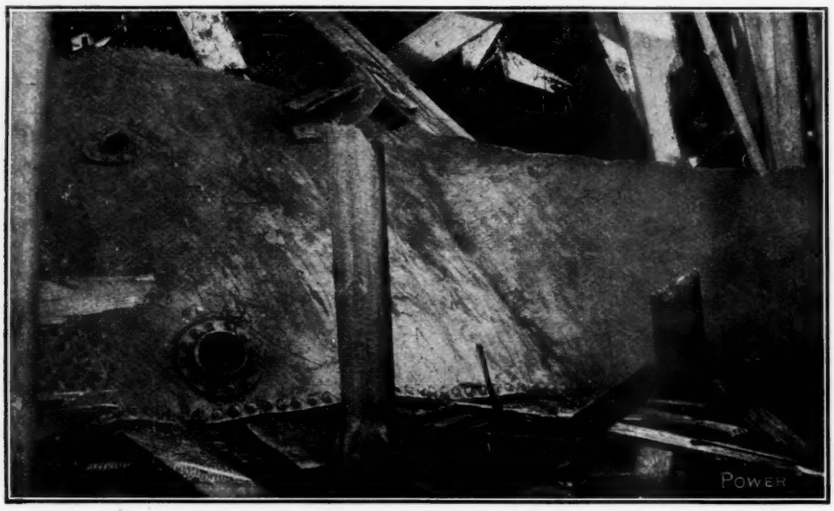


FIG. 4. HALF OF BOILER IN STANDARD OIL STABLES

FIG. 5. SAFETY VALVE YOKE IN WALL OF GROCERY STORE

Calculation of Heat Value of Coal*

By O. L. Kowalke

Simple formula and chart for figuring the heat value from the proximate analysis.

Another chart which gives the heat value per pound of combustible when the percentage of fixed carbon is known and from this the heat value of the coal is calculated by a simple process in percentage.

*Abstract of article in "The Wisconsin Engineer."

The heat value of a coal may, in general, be ascertained by two methods: (1) By actual combustion in a calorimeter, (2) by calculation from its analysis.

There is little doubt that the calorimetric test of coal is the best, but as the cost of the necessary apparatus is somewhat high for those who have only occasional determinations to make, the analysis may be performed in two other ways: (1) An ultimate analysis of the coal may be made, which gives the proportions of carbon, hydrogen, oxygen, nitrogen, sulphur and ash. The heat value may then be computed from the known heats of combustion of carbon and hydrogen, according to various formulas. (2) An approximate analysis may be made which gives the moisture, volatile matter, fixed carbon and ash. By means of empirical formulas or curves the heat value can be deduced.

The ultimate analysis of a coal is a difficult and tedious process and requires long practice for its accurate execution. There have been various formulas proposed for ascertaining the heat value from this analysis, and there is considerable difference of opinion as to the correct method.

In view of the complexity of the ultimate analysis, several methods have been proposed for calculating the heat value from the proximate analysis which is not difficult to make. In 1902, E. Goutal published a formula (*Comptes Rendus*, September, 1902; *E. C. & M. I.*, April, 1907) for calculating the heat value from the proximate analysis, the formula being based on a large number of tests of French coals. The formula, in English units, is as follows:

$$B.t.u. = 14{,}760\ C + a\ V$$

where the B.t.u. refers to coal as received, C the percentage of fixed carbon expressed as a decimal, V the percentage of volatile matter expressed as a decimal, and a the constant. A table of values of a was constructed in terms of the volatile matter V' in the combustible. The heat value is computed by multiplying the weight of fixed carbon, in decimal form, by 14,760, and the volatile matter V actually found by constant a corresponding to the volatile matter V' in the combustible, and adding these two products.

Since the formula and values of a were determined on French coals, it seemed desirable to evolve a set of values for a from American coals. It also seemed desirable to retain the formula

$$B.t.u.\ per\ pound\ as\ received = 14{,}760\ C + a\ V$$

but to give a directly in terms of the percentage of volatile matter in the coal as received. Accordingly, about 200 analyses of American bituminous and semi-bituminous coals were used to compute a set of values for a, and these were plotted in the form of a curve, Fig. 1, with the values of a as abscissas and the values of V as ordinates. The heat value of the coal as received is then the sum of the products of: 14,760 times the fixed carbon (as a decimal), and a times the volatile matter V (as a decimal) in the coal as found. This method and the values of a will give a result approximating the calorimetric determination within 2 per cent.

The following is an example: A certain coal contains: Moisture, 11.58 per cent.; volatile matter, 34 per cent.; fixed carbon, 40.63 per cent.; ash, 13.79 per cent.

According to the curve in Fig. 1, the value for the constant, a, is 14,050 when

the volatile matter equals 34 per cent. Then, substituting in the formula,

Heat value = 14,760 × 0.4063 + 14,050 × 0.34 = 10,773 *B.t.u.*

per pound of coal as received.

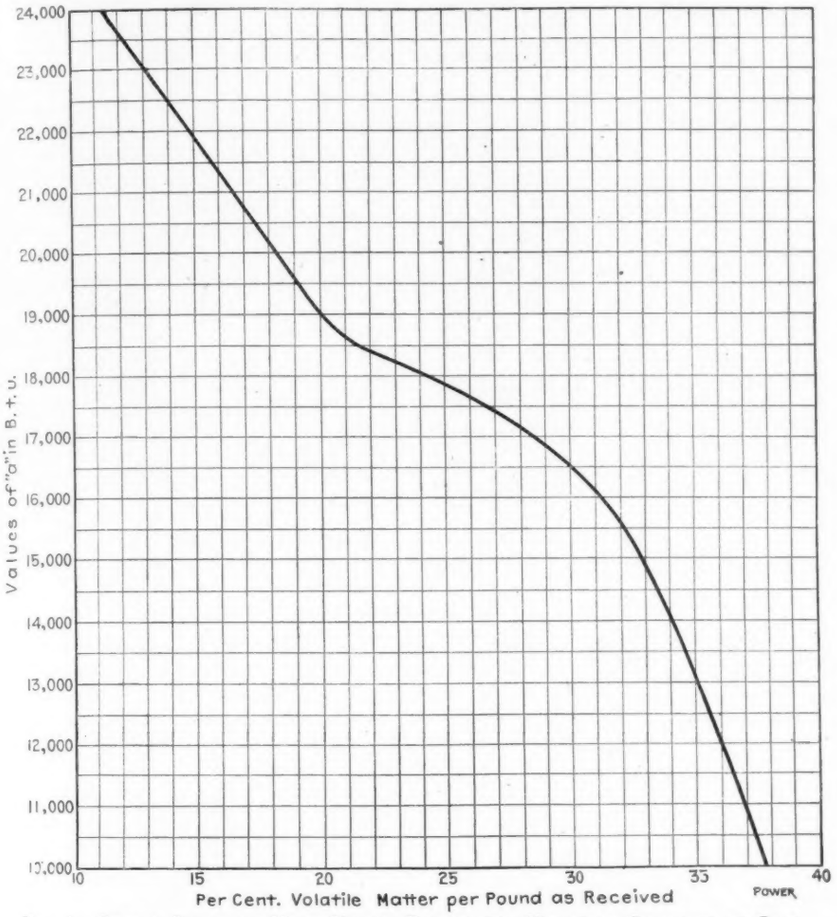


FIG. 1. CHART SHOWING HEAT-VALUE FACTOR FOR VOLATILE CONTENT OF COAL

The calorimeter test of this same coal indicated a heat value of 10,840 B.t.u. per pound. Thus the difference is only 67 B.t.u.

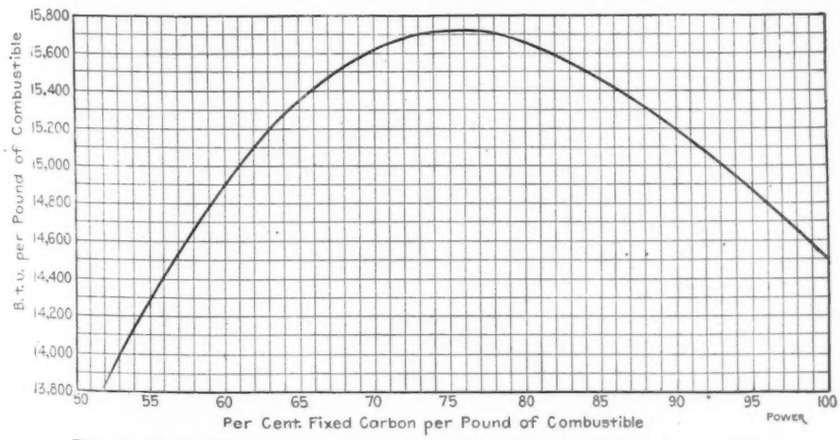


FIG. 2. HEAT VALUE OF COMBUSTIPLE BASED ON PERCENTAGE OF FIXED CARBON CONTAINED

It should be noted that this formula does not hold for anthracites low in volatile matter. Below 12 per cent. of volatile matter this method does not seem to hold true, but it does appear to give results approximately correct for coals having higher than 12 per cent. volatile matter.

The Under-Feed Stoker Co., of Chicago, has worked out a curve, Fig. 2, by means of which the heat value of the coal as received can be determined from the proximate analysis to an accuracy of about 2 per cent. Numerous checks with this curve against the calorimetric determination prove it to be substantially correct.

In this curve the percentage of fixed carbon per pound of combustible is plotted as abscissas, and the B.t.u. per pound of combustible is plotted as ordinates. The fixed carbon as found is recomputed on the basis of a pound of combustible—moisture and ash free coal. The B.t.u. on this curve corresponding to the recomputed value of the fixed carbon in the combustible is then multiplied by the sum of volatile matter and fixed carbon as found. The product is the heat value per pound of coal as received.

Using the previous example the following results are obtained:

Percentage of fixed carbon per pound of combustible equals

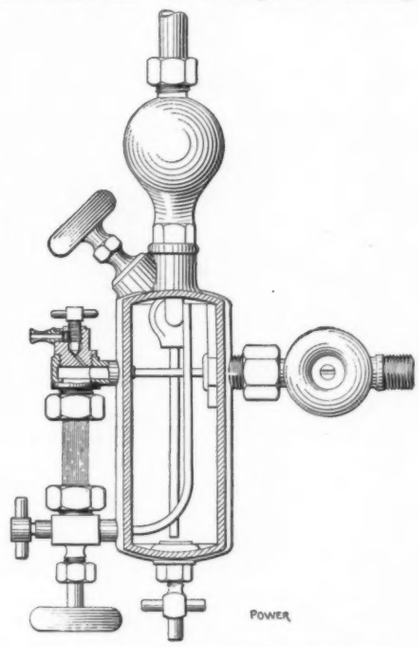
$$\frac{40.63}{74.63} = 54.4 \text{ per cent.}$$

According to the chart in Fig. 2, the heat value of one pound of combustible containing 54.4 per cent. of fixed carbon is 14,215 B.t.u. Then the heat value of one pound of coal containing 74.63 per cent. of such combustible matter equals

14,215 × 0.7463 = 10,609 *B.t.u.*

Lubricator Heating Attachment

A heating attachment for sight lubricators is being manufactured by J. H. Costello, Jr., Scranton, Penn. Its purpose is to permit steam to pass from the steam pipe which leads to the engine or pump, through the oil-discharge pipe of the lubricator and through the heating attachment to the atmosphere. The attachment is screwed into the opening above the sight glass and displaces the customary plug.



LUBRICATOR HEATING ATTACHMENT

This enables the lubricator to freely feed oil, especially when the lubricator is exposed to low temperatures.

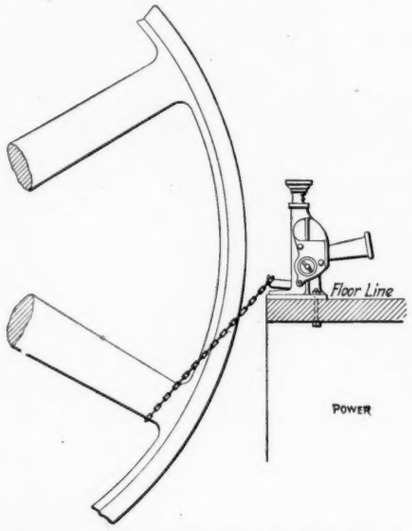
Readers with Something to Say

A letter good enough to print will be paid for. Ideas, not mere words, wanted

Engine Jack

A convenient rigging for turning an engine off center, when the wheel is not fitted for a bar, is shown in the illustration.

Any ordinary lever jack will answer, but it should be secured to the floor by a bolt, to keep it from tilting. A chain of the proper length is hooked to one



ENGINE JACK ATTACHED TO FLYWHEEL

of the lower spokes of the wheel, and brought up over the toe of the jack.

Two men can turn an 800-hp. engine off center in a few minutes with this device. I find this jack to be much quicker and more convenient than the chain block used in so many engine rooms.

F. P. READ.

Memphis, Tenn.

Case Hardening

I have never seen the subject of case hardening, or hardening by potash, discussed in these columns. It is of great value to engineers, and those that have small machinery to keep in repair. I find that it increases the life of wrought iron or machine steel to threefold of its ordinary wearing life.

The process is to pulverize yellow prussiate of potash, then heat the part of the machine to be hardened to a red heat, being careful not to burn or blister it. Next roll the part in the potash to get a good coating over the surface, and put it back in the furnace, and let it heat for a few minutes longer. Then take it out and give it another coating and cool it as quickly as possible, and it will acquire a surface so hard that it cannot be filed.

I have tried this on Corliss-engine radial rod pins to good advantage, on crosshead pins and crankpins on small engines. If any reader has a better or simpler process, I would be glad to hear of it.

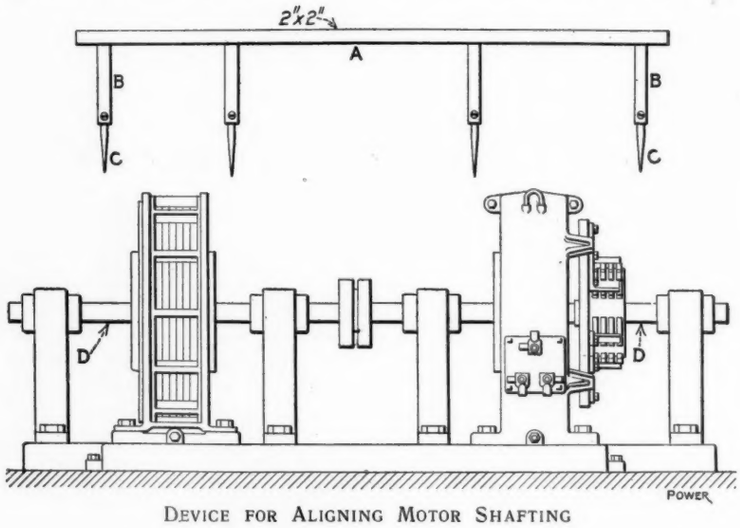
CHARLES MCCURDY.

Richmond, Va.

Template for Lining Shafts

The illustration shows a method of aligning a shaft. A 2x2-in. piece of wood of the length required is shown at *A; BB* are 2x2-in. pieces of wood of such a length that the spikes *CC* can rest on the shaft without the piece *A* touching any part of the machine.

The top of the piece *A* should be planed smooth for using a level thereon. The distance of the ends of the spikes *C* to *A* should be equal if the shaft is of the same diameter. By running a cord from the two end pieces *CC*, the center pins can be brought in the same line with reference to *A*, if the shaft is of the same diameter. Should the shaft not be the same diameter, the spikes can be adjusted accordingly.



DEVICE FOR ALIGNING MOTOR SHAFTING

The template is shown as applied to a motor-generator set in which the armatures could not be replaced without moving the frame of one after it had been trued up and leveled with the armatures out.

The center part of the shaft next to the coupling was of smaller diameter than its ends. The diameter of *D* and *D* being equal, *C* and *C* were made the same distance from *A*, and as the diameters of the center of the shaft were equal, but smaller than *D* and *D*, the center pins were made longer than *CC* by one-half the difference of the diameter of the shaft. Placing the template on top of the shaft and a level on the planed side of *A*, the shaft can be leveled in a horizontal plane.

F. J. FORBING.

Ft. Casey, Wash.

Graphite as a Preventative of Scale Formation

Several years ago I had trouble with leaky boiler tubes and badly corroded boilers. The firm had several samples of the feed water analyzed and used several different boiler compounds, each especially prescribed as a remedy for our trouble, but the scale and leaks were steadily getting worse.

A few weeks before I took charge of the plant two boilers had to be entirely retubed; flanges on the steam lines leaked as the compound ate out the gaskets, and the piston-rod packing was troublesome.

As soon as we shut down I had each boiler cleaned, scaled and washed out. In the six months before the shutdown I put in over 200 new tubes, and during the shutdown 27 more.

There were three boilers in a separate battery from the rest, which had given us trouble, as they were driven very hard. I decided to experiment with them and find some means to prevent

the interior corrosion and scale formation. After using soda ash, kerosene and most everything else with little success, I decided to try graphite. The firm ordered some powdered graphite and before the boilers were closed up I put about three quarts in each.

On the fifth morning the engineer on watch informed me that the blowoff valve of one boiler was stopped up and could not be blown down. I tried to clear it several times during the day but could not. I had the boiler shut off and the fire hauled, and on removing the bottom manhole plate a great quantity of scale was found in the blowoff pipe. The graphite had worked in behind the old scale and loosened it up. I made a practice of putting in a small quantity each day with the feed water and found that it prevented further scale from forming and it loosened the old scale.

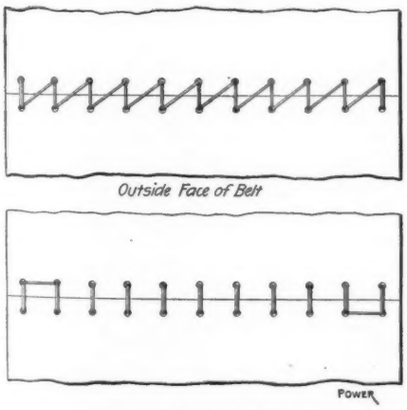
One great advantage in using graphite is that it is insoluble and will not go out of the boiler with the steam; its action is mechanical, not chemical and does not injure the boiler shell or the tubes.

W. V. FORD.

Norwich, Conn.

Belt Lacing

I am a firm believer in wire lacing for nearly all belts. I have charge of six belts, 18 to 24 in. wide, all laced with soft-brass wire; one belt has eight joints in it and some of the lacings have been in for over 10 years. I have had no trouble whatever with any of them. I use wire lacing for lathe belts and for



INSIDE FACE OF BELT

belts running over pulleys as small as 2 in. in diameter.

If the belt is laced properly (and that is half the secret), it will hold against any lacing. After the belt is laced the wire must be driven into the belt until it is flush with its face so that it cannot touch the face of the pulley. The following are the rules we use: Punch holes back from the end about the thickness of the belt; have the holes about ½ in. apart, 9 or 10 to 4 in.; cut off a piece of wire seven times the width of the belt (9 to 10 times the width for double belt); begin at the center, double lace each hole as shown in the accompanying figure; do not let one strand overlap another; pull each strand tight with pliers; double lace the last hole and pass the end through the next inner hole; cut off the end of the wire ½ in. from the belt and bend it over toward the joint; then flatten down the whole joint with a hammer.

J. N. FRIES.

Middleboro, Mass.

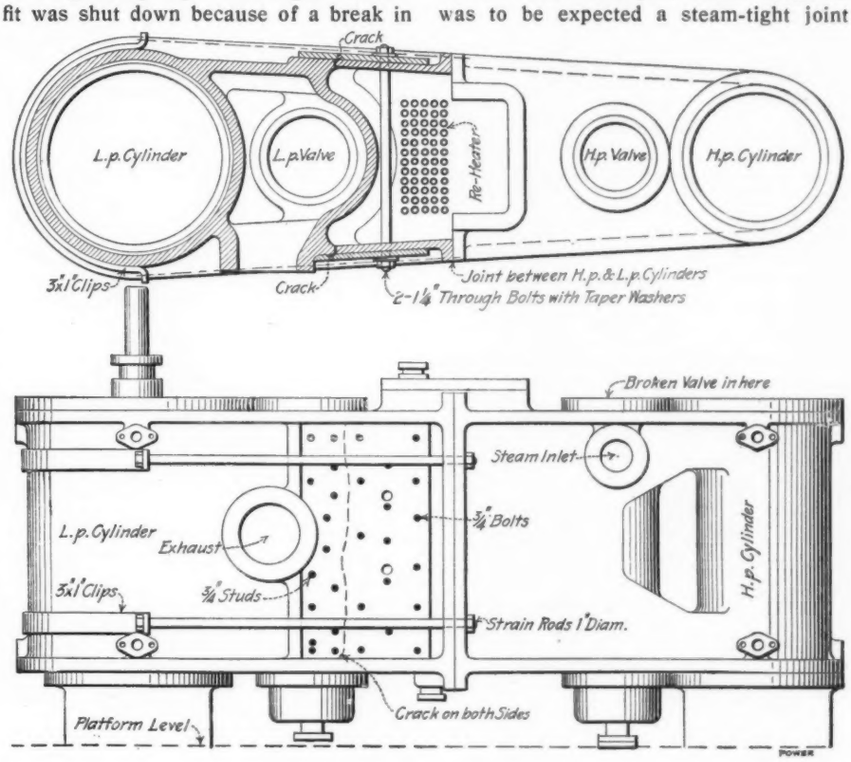
Repair of Cracked Receiver

The main 16 and 34 by 30-in. 400-hp. cross-compound vertical engine was fitted with a Meyer piston valve, and drove a 16-in. gravel pump. One night the outfit was shut down because of a break in the pipe line and as the delivery column was 150 ft. long and ran at a steep angle, the lower sections of the piping and the pump itself were jammed solid with drift. It was difficult to get a start short of opening up the pump and cleaning it out; and the sledge-hammer method used was to get a full head of 160 lb. of steam on the engine, four or five husky helpers on each starting bar, and a stream of water pouring into the pump case through a special cock.

Attention was first centered on the pump, and all hands were surprised to find the air full of flying asbestos and steam. When the fog cleared away, a vertical crack was found in the main receiver between the high-pressure and the low-pressure cylinders. This receiver contained the tube reheater, and was of box shape and much of its area was unstayed, the metal being about 1 in. thick, but the heavy parts were irregularly disposed. There was a crack about 3 ft. long on each side of the receiver body, as shown in the sketch.

The trouble was caused by a ring on the high-pressure main piston valve breaking, jamming and knocking the flange off the valve which admitted the high-steam pressure into the receiver at a time when the engineer's attention was distracted. As he could not see the receiver gage from the starting wheel, he was unaware of the sudden increase in pressure.

The reheater was dismantled, the drain pipes, covers, asbestos, etc., were removed and the drilling of holes started. As the crack was just where vibration was to be expected a steam-tight joint



HOW THE RECEIVER WAS REPAIRED

had to be made. Bolts, studs and cap-screws were used and also two 1¼-in. through bolts to draw the sides together. The two ¾-in. plates, 3 ft. wide, 4 ft. long, were made to fit snug between the top and bottom flanges of the receiver and holes were drilled in them to line up with those in the sides of the receiver.

The first joint was made with metallic cement and was a failure. Much disgusted, I had everything ripped out again and remade the joint with a red-lead putty and chopped-hemp mixture, with a liberal allowance of lead wire disposed where it would do the most good. On tightening up the bolts, the plates were tapped evenly with a sledge to bed them, and everything was pulled home snug.

This time it was no experiment and the receiver warmed up without a weep and carried full load without any further trouble.

J. McA. Howden.

Melbourne, Australia.

Strengthening a Cracked Cylinder

The accompanying sketches show two repair jobs of cracked cylinders. Referring to Fig. 1, the crack in the cylinder barrel is shown at *A;* a clamp, *B,*

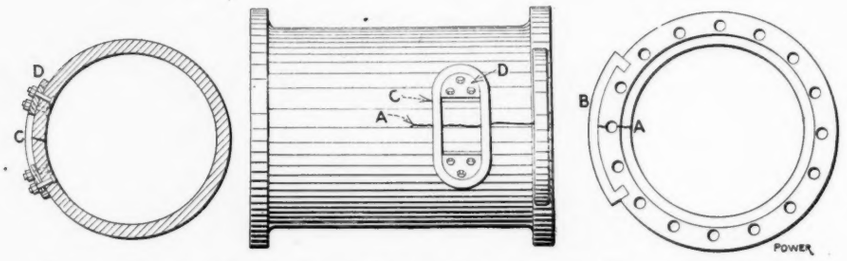


Fig. 1. Cracked Cylinder and Method Employed in Applying the Clamp

was made and put in place, as shown, while hot. The link strap *C* is made of round iron and is 18 in. long. The iron blocks *DD* are 1 in. thick and fit in the link. One of the blocks must first be secured in place by three bolts. Then put on the second block and drill the bolt-holes ⅛ in. beyond the point scribed on the cylinder through the holes in the block. Next secure the block and heat the link red hot and put it over the blocks as quickly as possible.

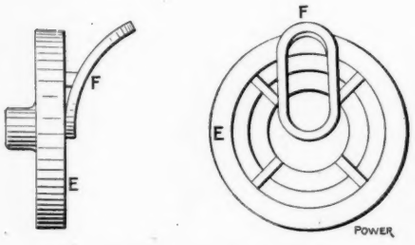


Fig. 2. Machining the Link

In Fig. 2, at *E* and *F* is shown the link in a lathe for machining out the ends which fit around the blocks.

J. G. Koppel.

Montreal, Que.

Purchasing Instruments

To what extent should an operating engineer invest his money for instruments, such as an indicator, calorimeter, portable CO_2 apparatus, etc., when he is working for a company having ample means to purchase anything necessary for economically operating its power plant?

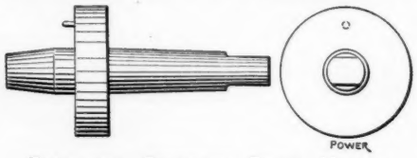
Frank Martin.

College Point, N. Y.

Valve Grinding Tool

It is often necessary to regrind brass pump valves and the easiest method of doing this work is by the use of an air drill. When the valves are cast with projections on top it is an easy matter to apply the power of the drill to them, and if the valves are perfectly smooth on top the tool shown in the sketch is very efficient for this purpose.

In the sketch, an old tapered drill shank with the taper on the upper end, is shown, which fits into the body of the air drill. About 3 in. from the end is a 1½-in. collar, perhaps ⅜ in. thick. This is put on with a driving fit. From the lower side of the collar a 1½-in. pin projects about $\frac{3}{32}$ in. The drill shank extends 1 in. below the collar and is ground down so as to fit loosely into the



Tool for Grinding Pump Valves

hole in the valve seat ordinarily occupied by the valve stud. With a $\frac{3}{32}$-in. drill a small hole is made in the top of each valve just deep enough to engage the small pin. With the valve in position and the drill shank in the air drill, the valve can be quickly and easily ground.

If the pump is small the valves in the lower deck will have to be ground by means of an extension made with a taper at one end and a sleeve at the other.

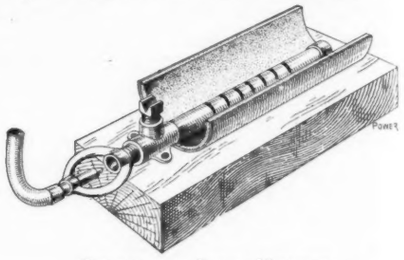
Owen W. Middleton.

Chicago, Ill.

Handy Soldering Iron Heater

The base of the heater is a block of wood about 1½ in. thick by 3½ in. wide and is 8 in. long. Then cut out a piece of sheet iron or heavy tin 5 in. wide and 5¼ in. long; also a piece of heavy sheet asbestos of the same dimensions. The piece of sheet iron is bent into the form of a half circle, the bend being made parallel with the long sides. The piece of asbestos is soaked in water to make it pliable and then pressed against the inside of the half circle of sheet iron, to form a lining to hold the heat. The whole is then attached to the block of wood, with nails, as shown in the illustration. The iron hood comes almost flush on one end of the block, leaving a space on the other end to fasten the tee.

The burner is made out of a ½-in. nipple, 5½ in. long and 15 slots cut half way through it with a hacksaw about ¼ in. apart. One end of the nipple is capped and the other end is screwed into



Soldering Iron Heater

a ½-in. gas tee. It is then fastened to the block with the slots on top.

The side opening of the tee is plugged and a notch filed in the top as a rest for the handle of the soldering iron. The frame of an old sprinkler head is screwed into the other end of the tee and serves as a bracket to hold the gas jet, which is a piece of ⅜-in. brass tube 2½ in. long and reduced to $\frac{1}{16}$ in. at the end next to the burner. The hole in the end of the bracket should be reamed so that the brass tubes will fit snugly. It can then be moved in or out, until it is in the right position relative to the air inlet. If there is no sheet asbestos at hand, asbestos cement or even fireclay will do for the lining.

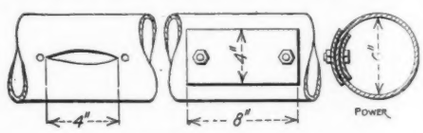
George J. Little.

Passaic, N. J.

Patched Steam Pipe

A long-radius 6-in. steam pipe fractured, and to replace it with a new one would have taken too much time.

The fracture was repaired by sawing out a piece of 6-in. pipe and cutting it into two 4x8-in. pieces. Two ⅜-in. holes were drilled in each 8-in. piece of pipe, as shown, also two holes in the fractured



Patched Steam Pipe

pipe to match. I then cut two pieces of ¼-in. packing to put under the two patches, which were placed on the inside and outside of the fractured pipe. Then the plates were bolted tightly together, as indicated, with ⅜x2-in. bolts.

The job necessitated about 30 min. shutdown, and the patch is still tight.

L. H. Wadsworth.

Hooper, Utah.

Wavy Expansion Line

The accompanying diagrams were all taken from a 26x48-in. Corliss engine running at 90 r.p.m. The boiler pressure is 115 lb., gage.

It will be noted that the diagrams in Figs. 1 and 4 have wavy expansion lines.

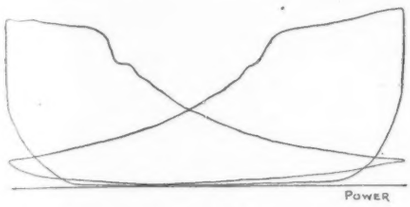


FIG. 1. EFFECT OF THREE-WAY COCK

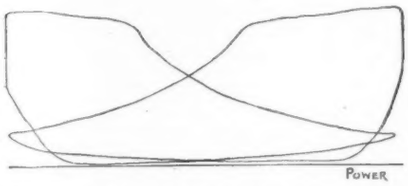


FIG. 2. DIAGRAMS TAKEN WITH THREE-WAY COCK REMOVED

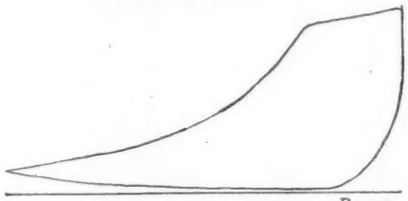


FIG. 3. DIAGRAM TAKEN WITH ONE SIDE PIPE REMOVED; INDICATOR CONNECTED DIRECT

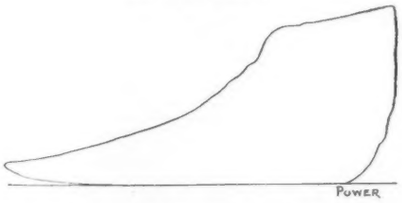


FIG. 4. DIAGRAM TAKEN WITH ONE SIDE PIPE REMOVED

Apparently these are due to the manner in which the indicator is attached. I took two series of diagrams; in one series I used a Crosby indicator and in the other a Lippincott. For corresponding conditions the diagrams from both indicators were exactly alike, so I feel justified in saying that the waves are not due to the indicator.

The diagrams in Fig. 1 were taken with the indicator piped as shown in Fig. 5, a three-way cock being used to control the steam. The diagrams in Fig. 2 were taken with the indicator piped as shown in Fig. 6, a tee and two-way cock taking the place of the three-way cock. The diagram in Fig. 3 from the crank end was taken after removing the side pipe *A*, Fig. 5, and turning the angle valve *B* around to the proper position to carry a short nipple and the indicator. The diagram in Fig. 4 was taken after removing pipe *A*, Fig. 5, and substituting an ell for the three-way cock.

From the foregoing it will be seen that an apparently slight change in the piping arrangements has a marked effect on the expansion line. The boilers which supply this engine prime considerably and the steam is always very wet. Whether this is a contributing condition or not, I cannot say. I would request the opinion of other readers of POWER on this interesting case.

J. W. DICKSON.

Memphis, Tenn.

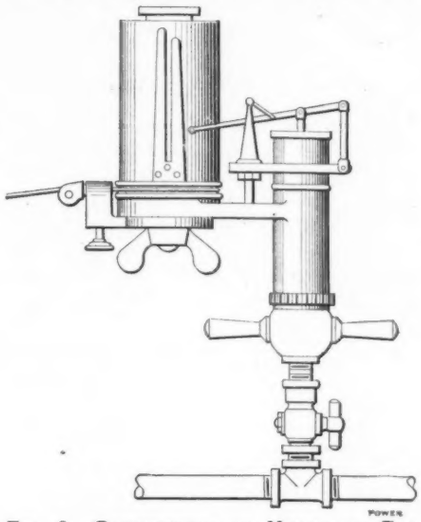


FIG. 6. CONNECTION BY MEANS OF TEE AND TWO-WAY COCK

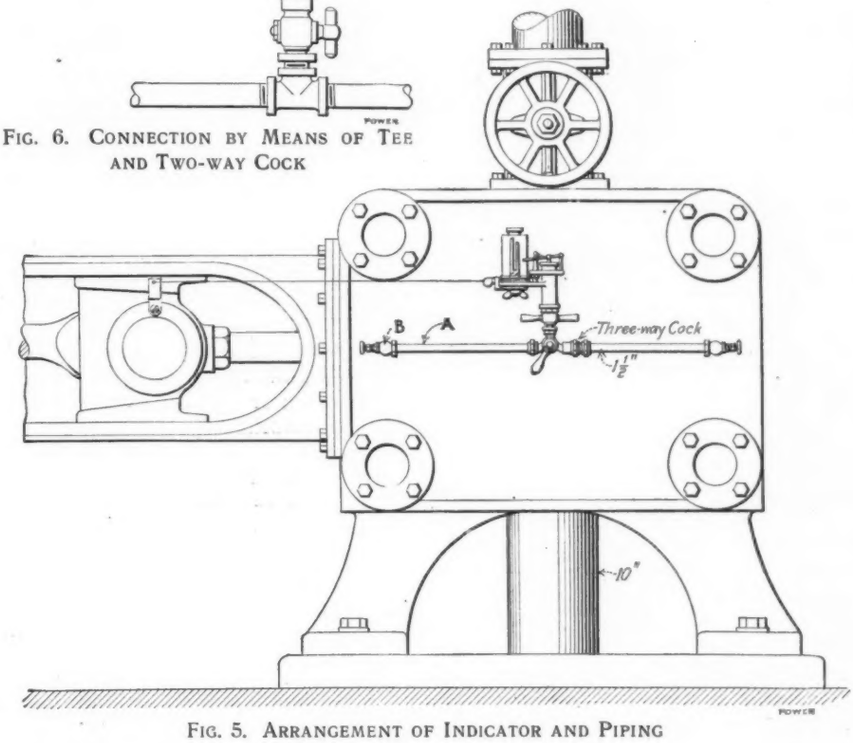


FIG. 5. ARRANGEMENT OF INDICATOR AND PIPING

Where a Record Was Valuable

During a high wind recently about 50 ft. of our 84-ft. stack was blown off. We had a new stack on the ground ready to put up, but the chief engineer was at a loss to know just which was the best way to raise it.

I immediately produced two clippings from my POWER file showing the erection of two different stacks with a good description of the erection of each. Both descriptions were accompanied with photographs taken during the different stages of erecting, which greatly helped the chief.

WALTER B. BROWN.

Deshler, Ohio.

Cleaning A Closed Heater

The ordinary method of cleaning out closed feed-water heaters of the straight water-tube type is to take off the upper head and clean the inside of the tubes with some sort of flue brush. The labor involved in breaking the pipe connections, disconnecting the upper head and boring the tubes of a good-sized heater is a serious item, and as the coating of the inside of the tubes generally consists of oil which has come over with the feed water, the process of removal is quite difficult.

After one experience with a 600-hp. heater I found that by pouring in a bucketful of strong lye after the water had been blown out, then filling it with fresh water to within a few inches of the top, and admitting exhaust steam and letting the solution boil all night, that I had a clean heater the next morning and the labor bill was trivial.

Of course, it is necessary to blow the heater down several times before cutting in so as to prevent foaming boilers.

LINDSAY DUNCAN.

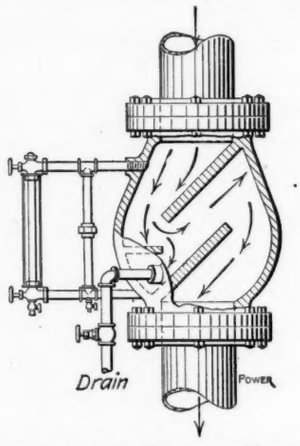
McGill, Nev.

Questions Before the House

Comment, criticism, suggestions and debate upon various articles, letters and editorials which have appeared in previous issues

Breakage of Separator Gage-Glasses

If J. W. Dickson and others who have had trouble with gage-glasses breaking will put in a section of pipe between the glass and the separator, they will find



ARRANGEMENT OF PIPING TO PROTECT GAGE GLASS

that fewer glasses will be broken. The accompanying figure shows the manner of constructing the pipe extension.

I have used this arrangement and have found that it holds glasses from 12 to 18 months where formerly they would have to be renewed weekly.

H. L. BURNS.

Caruthersville, Mo.

Lubricator Piping and Lubrication

Replying to E. H. Roberts' letter in the Mar. 12 issue, I say that, in theory, the principle of extending the oil-feed pipe to the center of the steam pipe is correct, but a practical experience of 12 years as an engineer has taught me that there is no material difference in the effect of lubrication whether the oil-feed pipe extends to the center of the steam pipe or ends flush with the inner side.

Where I am employed there are 28 lubricators feeding oil to steam cylinders and of these only one feeds the oil to the center of the steam pipe. This change was made about one year ago on a 400-hp. Corliss engine to determine whether there would be any noticeable effect on the action and wear of the valves, piston and cylinder. No difference has thus far been detected.

In our plant there is also a 200-hp. Corliss engine that has been turning 125 r.p.m., 24 hours per day, for three years without requiring any valve or cylinder repair. The valves and cylinder are in perfect condition today.

The oil is fed into the steam 1 ft. above the throttle valve and the feed pipe only extends flush with the inner side of the pipe.

According to Mr. Roberts, there would soon be a noticeable effect on the action of the valves and piston.

J. W. DICKSON.

Memphis, Tenn.

Valve Locking Devices

In the issue of Mar. 12 are described two methods of locking valves to prevent accidents while working on idle boilers.

A simple method is to remove the valve wheels from the main steam stop valve leading to the idle boiler as well as the blowoff and feed-water valve wheels after closing the valves. This prevents the opening of the valves inadvertently, and a wrench or wheel must be used to cause an accident.

J. J. DEVINE.

Philadelphia, Penn.

Visible and Invisible Leaks

"There are leaks"—how true the story in the foreword for Mar. 5. The engineer who will keep things clean and in good shape shows industry, anyway, which is a good sign, but many smooth-running, clean and neat engines are using from 40 to 60 lb. of steam per horsepower-hour. If this engineer were offered any suggestion, he would be offended; if he were to make a test of his machines, he would become indignant at the machines' own deception.

How many narrow pistons with small wearing surface are cheating; how many light-running square, rectangular and round-plug valves have a stream of steam from two to five thousandths of an inch thick flowing constantly to the atmosphere! Hidden leaks are the power plant's Jonah, and engineers should beware of them.

In many cases, the coal pile is being robbed. Many an engineer's job has been lost through the central station; it employs efficient machines and keeps them under constant observation.

Some funny things happen that never get into print. I told an engineer who had a fine tandem-compound engine that the rings in the low-pressure cylinder were gone. "No," he said; "she runs well and they were put in only a few weeks ago." When they were examined, to satisfy the management, those rings were in a dozen pieces. A dose of water may, some time, put the best set of rings out of commission.

In a large steam plant with the ring system of steam lines so many flange joints and throttle stems were leaking that when they all were packed it was possible to cut out a 72-in. by 18-ft. boiler. The engineer who keeps things clean would have stopped those visible leaks.

Not long since, I inspected a new plant containing return-tubular boilers where cinders and soot had closed off several of the bottom flues.

Much good machinery is poorly looked after, and many steam pumps waste more than they are worth every month. Good heaters are bypassed because of some needed repair or are running with a coating of scale on the tubes so thick that only half of the available heat goes into the water.

Know what a test is, and how to make one; then make one at intervals, keeping a log of the results obtained so as to know what the plant is doing.

I met an engineer recently who said of a fine "long-range" Corliss engine: "I would like it better if it had but the one eccentric; it would be simple, like mine."

When it is known what the apparatus will do, it should be made to do it. It should be known how much steam an engine requires; how much water the boilers will evaporate per pound of coal; how many heat units the coal has, and if it is up to standard.

If it is known that an 11x12-in. engine runs under certain conditions on 30 lb. of steam per horsepower-hour, these facts can be used as a standard. If one can do better, do it, and make an even better standard. We all can do better if we try.

C. R. MCGAHEY.

Baltimore, Md.

What Caused the Rod to Wear?

I think A. E. Kernick's trouble, described in the Feb. 13 issue, is due to chemical action. If the cylinder is not sufficiently oiled inside, the 12 in. of piston rod left inside the cylinder will

rust slightly each day during the 18 hr. the engine is idle. If tallow or other oil containing acid is used the rod will be attacked by the acid. In either case, the chemical action on that part in contact with the open air will not be as great as that inside the cylinder.

I would advise Mr. Kernick to leave the engine standing on the crank-end dead center.

Davidson, Okla. FRED BOONE.

Value of CO_2 Recorder

In looking over POWER of Feb. 13, my attention was attracted to the article of Mr. Pohlman's entitled the "Value of a CO_2 Recorder."

It is stated that the expert was able to obtain 16 per cent. of CO_2 in the flue gases. This seems unusually high and it may not be improbable that the expert was the only man who could obtain that percentage.

Hence, there should be no fault found with firemen if they in turn learned how to "jockey" the CO_2 machine so as to give a good reading if those in authority could be convinced that it is possible to get 16 per cent. On the other hand, I would like to know how it was decided that 11.5 per cent. was a good standard.

In a number of analyses of flue gases made recently I found all the way from 4 to 12 per cent. CO_2 and in no case would it have been possible to get as much as 16 per cent. except by closing the damper.

In the case cited by Mr. Pohlman the fireman cannot be blamed; the chief engineer, in my opinion, is culpable. If in addition to the CO_2 recorder he had provided himself with a good portable CO_2 analyzer and had gone over his boilers once in a while, he might have discovered something that would have paid for the trouble.

A case that came to my notice was in a plant of about the size mentioned by Mr. Pohlman. They had recently installed two water-tube boilers of a well known make which had been in operation perhaps nine months. Upon taking a sample of gas I obtained only 4 per cent. of CO_2, notwithstanding that the chief engineer assured me that the settings of the boilers were perfect. Several analyses were made but none contained over 7 per cent. of CO_2. Later on, when the chief opened the front and back doors we met with a sight that surprised the chief but was expected by me. A low percentage of CO_2 could only mean one thing to me; that is, too much air. Steps were taken at once to repair the furnace.

The plant that cannot be improved by an honest application of either a good CO_2 recorder or CO_2 hand apparatus is indeed an ideal one.

ALFRED FRANKLIN.

Cheltenham, Penn.

Advantage of Thorough Knowledge

I was impressed with J. L. Watson's article, "Lubricator Experience," in the Feb. 6 issue, for it enlightened me as to just why the sight-feed glass fills with oil at times. I had never taken the trouble to figure it out for myself; in fact, I could not have accurately described the construction of a lubricator beforehand, although I had a working knowledge of it.

A thorough knowledge of any piece of apparatus is good to have; it enables one to get the apparatus into trim quickly and easily when any trouble occurs. It is a misfortune to neglect to acquire detailed knowledge of the construction and care of even little things.

The apparent simplicity of a device may sometimes cause a lot of blind experimenting under very trying circumstances when a little previous study and investigation might have made the trouble quite easy to find and remedy.

LLOYD V. BEETS.

Nashville, Tenn.

Lubricator Experience

I would go further than L. J. Watson did on the above subject as regards cleaning and taking care of lubricators. While I was with a firm that habitually bought a cheap grade of oil, we had to take down the lubricators occasionally and give them a boiling out. To do this we had to remove the wooden handles and take out the glasses as they were boiled in a mixture of water and lye.

Finally I hit upon a new way which saved me the trouble of taking them down. I emptied the lubricator and filled it about two-thirds full of coal oil or kerosene, put in the filling plug, turned on the steam, and let it boil for a few minutes; then I gave it a good blowing out. Next I cut up fine a 1-in. cube of laundry soap, put it in the lubricator and filled the latter about two-thirds full of water. I then turned on the steam and let that boil for a few moments, and then gave the lubricator another blowing out.

By using this method, which only took a few minutes, I never had to take a lubricator down, and it was surprising the amount of sediment that came out.

Another way to keep a lubricator clean is to put in a piece of soap just before filling it with oil and when the oil is all fed out, give the lubricator a good blowing out.

As to the use of wrenches on lubricators, I find that the smaller the wrench, the longer the threads on the packing nuts will last. I have seen engineers use 12- and 14-in. wrenches to tighten up the packing nuts, and then wonder why they stripped the threads or twisted off a filling or a drain plug. If a packing nut is tight, it will always leak a little when turning on steam but in a short time it will tighten itself. I never use a wrench on the filling and drain plugs, as these joints are steam tight.

I once had charge of a plant which employed "hunkies" as firemen. One day the head fireman came into the engine room, a 12-in. Stillson wrench in one hand and a drain plug in the other. Showing me the plug, he said, "No good." When I asked him how he did it, he said, "Just tighten him up a little mit de wrench." I have tightened this same plug repeatedly with my hands, but he had to use the largest wrench he could find.

FRED LANGBEIN.

Port Clinton, Ohio.

In the Feb. 6 issue, L. J. Watson states that when the sight-feed glass fills with oil it is necessary to stop the feed, blow it out clean and let it fill with water, before restarting the feed.

I had a ½-gal. lubricator on which it was impossible to keep the sight-feed glass clear over 15 min. at a time, but just the same, it would and did feed itself empty three times during every 10-hour shift, night and day, for 10 years. We always had it blown out at the commencement of each shift.

W. E. STICKNEY.

Prince Albert, Sask.

Pressure in Pump Discharge Pipe

J. C. Hawkins gives, on page 870, in the issue of Dec. 5, 1911, a solution of the pumping problem presented by J. F. Murphy, on page 638, Oct. 24, 1911, in which he reaches the conclusion that nearly five times as much water will be pumped into the higher tank as into the lower one. Eliminating the errors from Mr. Hawkins' calculations, it will be seen that under the conditions given no water will be pumped into the higher tank.

The displacement of the pump, at a piston speed of 100 ft. per minute, is $10^2 \times 0.7854 \times 100 \times 12 \times 2 = 188{,}496$ cu.in. per minute, or 816 gal. per minute. Allowing for slippage, 612 gal. per minute will be delivered to the discharge pipe.

In order to determine whether any water will be discharged into the higher tank, it is necessary to calculate what head must be impressed upon pipe E, to deliver 612 gal. per minute (10.2 gal. per second) into the lower tank.

A flow of 10.2 gal. per second through a 3-in. pipe necessitates a velocity of

$$\frac{10.2 \times 231}{3^2 \times 0.7854} = 333.3 \text{ in. per sec.}$$

or 27.7 ft. per second. The effective head to produce this velocity is found from the formula

$$v^2 = 2gh$$

h being head in feet, and v, velocity in feet per second, from which

$$h = \frac{27.7^2}{64.32} = 11.9$$

To this velocity head must be added the friction head in the pipe, which can be determined from the formula

$$h' = f\frac{4l}{d} \times \frac{v^2}{2g}$$

in which l is the length and d the diameter of the pipe in feet, and f the coefficient of friction, for which 0.01 is an average value. Since the pressure on the pump due to the hydrostatic head in the 3-in. pipe is given as 20 lb., the length of this pipe may be assumed to be 20 ÷ 0.434 = 46 ft. Substituting these values, the formula becomes

$$h' = 0.01 \times \frac{4 \times 46}{0.25} \times \frac{27.7^2}{64.32} = 63.8 \text{ ft.}$$

The velocity head being 11.9 ft. and the friction head 63.8 ft., the total will be 75.7 ft., so that the water would rise in the 6-in. pipe to a height 75.7 + 46 = 121.7 ft. above the horizontal pipe, and then be nearly 65 ft. below the bottom of the upper tank. Thus the 3-in. pipe is found to be large enough to discharge to the lower tank all the water the pump can deliver at the given speed.

Mr. Hawkins' errors consisted in using 100 r.p.m. for the pump speed, instead of 100 ft. piston speed, and in an incorrect application of the chart for "Flow of Water in Iron Pipes," shown on page 523 for Apr. 23, 1911. This chart gives frictional head per 1000 ft. of pipe, while it was used in this case as though it showed total head, without regard to length of pipe.

C. S. STOUFFER.

Kewanee, Ill.

Clerical Work in Station Reports

Commenting on H. S. Knowlton's article, "Saving Clerical Work in Station Reports," in the Mar. 12 issue, I wish to say that I agree with him that the main duty of an engineer is to keep his plant in good condition and operate it efficiently; yet few men, and particularly those not connected with the engineering or accounting departments of a plant, realize the importance of well kept records.

Mr. Knowlton aptly characterizes the records as part of "the old man's red tape," and that is the feeling held by most men who have to fill them out. The engineer ought to keep these records rather than leave them to the old man.

The series of articles on the "Confessions of an Engineer," appearing in POWER from time to time, give examples of cases where the information contained in such reports would have been valuable to the engineer as well as to the old man.

The use of letters or symbols to indicate the various things that should be recorded is not to be wholly commended as there will probably be more work added in making out the key than will be saved by the use of a single letter instead of several words; of course, where the key is printed upon the form or the record covers a period of perhaps a month, this criticism would not apply.

As all of the occurrences reported by letters will not be the same, and, as in the case of accidents, it is well to have detailed reports so as to guard against their future occurrence or to place the blame where it properly belongs in case of carelessness, it is doubtful if the symbols would prove to be entirely satisfactory.

Leaving the vowels out of most of the words and otherwise condensing them, would appear to be even less satisfactory than the use of symbols. If all engineers were good penmen there would be little reason for objecting, but the probable result would be a misunderstanding of the true meaning, thus defeating the purpose of the records.

The plotting of a curve means the quickest and easiest means of judging results, and especially comparative results; but it is difficult to make use of more than one or two of such curves at a time unless they are all plotted on the same sheet. If it is necessary to take figures from the curves it will be found harder work than to merely copy from a column of figures. Again, there is more liability of making a mistake in putting down readings by making a check mark on cross-section paper than if the figures were written down; also, little, if any, time or labor will be saved as it will be necessary to find the intersection of the proper lines before making the mark.

The suggestion of keeping a handy list of constants ordinarily used is a good one and will save much time and avoid mistakes in arithmetic when results have to be worked out in a hurry.

G. H. MCKELWAY.

Brooklyn, N. Y.

Glass in Hot Box

In the Mar. 5 issue, John Bailey inquired about glass for hot boxes An experience I had some time ago with a 750-hp. engine may be of interest.

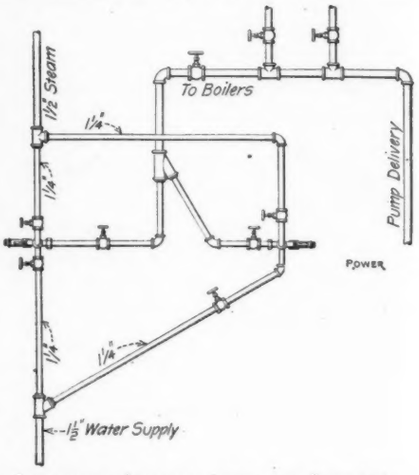
The outboard bearing got hot one evening about 10:30, and cylinder oil was run into it until morning, but it kept at about the same temperature. In the morning the engine was shut down, the cap was taken off and it was found that the babbitt had been started a little. As soon as the cap was taken off, the engine was started up again and some ground glass was put into the box. This did not seem to cool off the box, but I think that it must have smoothed up places where the babbitt had started, for after four hours' work the bearing was running as cool as ever.

CLARENCE R. DAVIS.

East Boston, Mass.

Will the Injector Work?

Referring to J. L. Brouse's drawing in the Mar. 5 issue, I do not consider his method of connecting up two injectors, in accordance with good practice. I assume that the main steam supply to the injectors is only 1¼ in. in size. Since



IMPROVED ARRANGEMENT OF INJECTOR PIPING

each injector requires a 1¼-in. steam supply, I should run at least a 1½-in. supply to the tee where a 1¼-in. branch is taken off for each injector, as he wishes to run both injectors together at times. This also applies to the water-supply pipe.

His method of connecting the delivery pipes together could be improved by using the arrangement shown in the accompanying figure. I believe that one injector alone would deliver more water to the boiler than the two together, connected as they are now.

New York City. THOMAS BAKER.

Cold Air and Leaky Pipe Joints

Mr. Normand's theory of flange contraction, as expressed in the issue of Feb. 13, would be all right if the cold draft blew all around the flange, but most drafts come from one side only, and cause a distortion of the flange that in many cases makes a leak.

Several years ago I was on a steam boat, on which one of the flanges on the main steam pipe came under the ventilator. It was impossible to keep this joint from leaking.

There was no vapor from the leak but hot water came down. By keeping the ventilator turned away from the wind the leak was not so bad. A shield was put over the pipe and there was no more trouble with it.

Chicago, Ill. C. G. HARDEN.

Inquiries of General Interest

Questions are not answered unless accompanied by the name and address of the inquirer. This page is for you when stuck—use it

Bare Steam Pipe

What is the loss per hour due to radiation of an uncovered steam pipe 8 in. in diameter and 170 ft. long, if the steam pressure is 120 lb. and the average temperature of the air is 70 deg. F.?

R. O. R.

The temperature of steam at 120 lb. gage pressure is 350 deg. F. The difference between the steam and air is therefore 280 deg. F. For most practical purposes the loss of heat from a bare steam pipe may be taken at 3 B.t.u. per square foot per hour per degree difference in temperature. The actual loss depends on the length and diameter of the pipe, whether vertical or horizontal, and the velocity of the air currents surrounding the pipe. The loss in 1 sq.ft. per hour would be theoretically $3 \times 280 = 840$ B.t.u.; 170 ft. of 8-in. pipe has an external surface of

$$170 \times \frac{8.625}{12} \times 3.1416 = 383.86 \text{ sq.ft.}$$

therefore the calculated loss of the whole length of pipe would be

$840 \times 383.86 = 322{,}442.4$ *B.t.u. per hour*

Pressure of the Wind

If the wind blows at the rate of 60 miles an hour, what would be its pressure on a flat surface?

E. H. S.

The wind pressure per square foot on a flat surface is about 0.004 times the square of the velocity of the wind in miles per hour. The value of the multiplier varies somewhat according to observations made by different men, being 0.005 according to Smeaton and 0.0029 according to Wipple and Dines. At the rate of 60 miles the pressure on a flat surface would be about $60^2 \times 0.004 = 14.4$ lb. per square foot of surface.

Compression Pressure in Natural-Gas Engines

What compression should a natural-gas engine have to operate to best advantage?

C. W. A.

Most natural-gas engines operate with a compression of about 120 lb. per square inch absolute, but there are several types built to run with pressures, running up to 135 lb. absolute.

Heat Loss in Flue Gas

What is the method of figuring the proportion of heat lost in the gases escaping from a chimney?

M. E. S.

Add 1 to the weight of air used per pound of combustible and multiply the sum by the difference between the temperature of the entering air and that of the flue gases; multiply again by the specific heat of the gases, which may be taken as 0.24 for most purposes. Divide the final product by the heat units per pound of coal. For example, if the temperature of the entering air is 60 deg. F. and that of the flue gases 420 deg. F., the air supply per pound of combustible 12 lb. and the heat value of the coal 13,320 B.t.u. per pound, the heat carried away by the flue gases would be

$$(12 + 1) \times (420 - 60) \times 0.24 = 1123 \text{ B.t.u.}$$

which is

$$\frac{1123}{13{,}200} = 0.085$$

or 8.5 per cent. of the total heat supplied.

Type Metal for Lining Bearings

Will type metal make good bearing lining?

P. K. I.

It will. Type metal is made of lead and antimony, the antimony varying from 18 to 22 per cent.

Air Required for the Combustion of One Pound of Coal

What is a good rule for estimating the amount of air required for the combustion of one pound of coal?

T. H. H.

Multiply the per cent. of carbon in the coal by 11.52. Multiply 34.56 by the difference between the per cent. of hydrogen and the quotient of the per cent. of oxygen divided by 8. Multiply the per cent. of sulphur by 4.32. The sum of all the products will be the theoretical amount of air required in pounds per pound of coal. The rule expressed as a formula is

$$11.52\,C + 34.56\left(H - \frac{O}{8}\right) + 4.32\,S = \text{pounds of air per pound of coal.}$$

Relative Sizes of Boiler and Engine

Can a 50-hp. engine be operated at full load by a 50-hp. boiler?

G. O. S.

It depends upon the type of engine. One boiler horsepower will furnish sufficient steam to develop about 3 hp. in a compound-condensing engine, and only ½ hp. in a small noncondensing engine. Assuming the engine to use 40 lb. of steam per horsepower per hour, the steam pressure to be 90 lb. gage and the temperature of the feed water 200 deg. F., the factor of evaporation would be

$$\frac{1187.2 - (200 - 32)}{970.4} = 1.05$$

The water used by the engine would be $50 \times 40 = 2000$ lb. per hour, or $2000 \times 1.05 = 2100$ lb. from and at 212 deg. F. The boiler horsepower necessary to supply steam to run the engine full load would be

$$\frac{2100}{34.5} = 60.8 \text{ hp.}$$

Gas-Engine Valves

Does a gas engine operating with natural gas have valves differently designed from those of an engine using other fuels?

A. F. W.

The design of gas-engine valves does not depend upon the kind of fuel to be used in the engine; it depends on the piston speed and the allowable velocity of gases through the valve ports. Some designers allow a velocity of 5000 ft. per minute past the valves, but more conservative designers put the speed at about 4000 ft. per minute.

Proper Side of a Belt Next to Pulley

Which is the proper side of a belt to put next to the pulley?

B. A. K.

The strongest part of belt leather is near the flesh side, about one-third the way through. It is therefore better to run the hair side on the pulley, in order that the strongest part of the belt may have the least wear. The flesh side will not crack, as the hair side will do, when the belt is old; therefore it is better to crimp the grain than stretch it.

To Aid the German Technical Arts Commission

As announced in POWER of Apr. 9, the Commission of the German Museum of Masterpieces of Natural Sciences and Technical Arts is visiting this country for the purpose of bringing the German Museum at Munich into close touch with the institutions in the United States devoted to the history of technical science.

While Munich has a world-wide reputation for its fine art collections, it is not so well known that it also possesses the finest collection of technical achievements in the whole world embodied in the German Museum. This museum is an establishment of technical art and science, and as such is unique in Europe.

As the committee has only a limited time at its command, it would like such Americans as sympathize with its mission to come forward with a view to facilitating an early communication.

If those who are able to provide facilities to the commission in the execution of its work here, or want to communicate with the members, will send their mail in care of POWER, we will gladly undertake to forward it and render any other assistance possible to make the commission's labors productive of benefit both here and abroad.

Largest Turbine for Chicago

London's newspapers regard as a commercial triumph the fact that C. A. Parsons & Co., of Seaton-on-Tyne, have received an order from the Commonwealth Edison Co., of Chicago, for a turbine which will be the largest in the world. It is divided into a high- and low-pressure portion, the high-pressure being of the single-flow type and the low-pressure element, double-flow; but the design is of the Parsons reaction type throughout and no velocity stages are used. Its sustained capacity is 30,000 kw. and it is guaranteed to produce a kw.-hr. on 11¼ lb. of steam with an initial pressure of 200 lb., superheat of 200 deg. and a vacuum of 28½ in.

Boiler Explosion near Carthage, Mo.

On Apr. 2, a vertical boiler at the mill of the Ida H. mine, near Carthage, Mo., exploded and seriously injured two mill workers. The cause is unknown to the employees, who declare that there was plenty of water in the boiler and that the gages were satisfactorily tested before starting.

Yale Students on Inspection Tour

Fifty-four seniors of the Sheffield Scientific School, Yale University, New Haven, Conn., under charge of Profs. Breckenridge and Roe, recently made a tour of inspection of the largest industrial plants of the country. The photograph, which was taken on Apr. 2, shows the class at the works of the Mesta Machine Co., at West Homestead, Penn.

The average under-graduate, who has never performed actual service in any industry, has practically no idea of the magnitude of the iron and steel manufacture and its allied industries and great benefit has resulted from these inspection tours. They show the student, who has finished the theoretical part of his education, exactly how the manufacture is carried on, particularly as applied to the building of the larger classes of machinery.

GROUP OF STUDENTS FROM SHEFFIELD ENGINEERING SCHOOL OF YALE

New Petition in Rate Discrimination Case

Much speculation centers around a petition which was presented to the Public Service Commission last Monday by Arthur S. Luria, representing the Isolated Plant Publishing Co. and some 400 consumers of Edison current.

Hearings upon the original complaint charging the New York Edison Co. with rate discrimination have been in progress for some months and have had the backing of a number of stationary engineers' organizations. Last Monday, Mr. Bronson, counsel for the complainants, summed up his case, asking that a decision be rendered upon the evidence already submitted. Mr. Luria, however, urged that the new petition be considered along with the existing complaint and the commission ruled in his favor.

While the exact nature of the evidence to be submitted under the new petition has not been disclosed, it is understood that the present classification of rates is to be accepted and the case conducted on definite lines tending toward a reduction in the maximum rate and fixing a limit to the discrimination between wholesale and retail rates.

Much damaging evidence was brought out at the former hearings but a definite procedure was frustrated by the refusal of the defendants to furnish the information asked for by the commission. Supplemented by the existing evidence, a new line of action should bear fruit. Meanwhile the proceedings will be watched with interest.

Newark Industrial Exposition

The publicity managers of the coming industrial exposition to be opened in Newark, N. J., on May 13 to 25, announce that it will aim to be the greatest civic event in the United States this year. It will be opened by President Taft and conducted under the auspices of the Newark Board of Trade.

The exhibitors include the manufacturers of the city's industrial district, and many companies that will be represented are the leaders of their kind in the world.

In conjunction with the preparation for the display there is being conducted a national advertising campaign, designed to give publicity to the exposition and make known to the country the opportunities offered by Newark as a city.

There will also be a large number of live exhibits, where a great variety of modern machinery will be seen.

Further information concerning the exposition can be had by addressing Newark Industrial Exposition, Board of Trade, Newark, N. J.

SOCIETY NOTES

The American Institute of Steam Boiler Inspectors of Boston will hold its annual banquet at the American House on the evening of Apr. 23.

The American Philosophical Society, the Franklin Institute, the American Chemical Society, and the American Gas Institute will hold a symposium in celebration of the centenary of the introduction of gas as an illuminant in Philadelphia, on Apr. 18 and 19. The place of meeting will be the hall of the Franklin Institute.

Elaborate preparations are being made by the local association for the reception of the National Electric Light Association at Seattle, Wash., during its thirty-fifth annual convention on June 10 to 14. Intending visitors are asked to apply to W. J. Grambs, chairman of the hotel committee, as early as possible for their hotel accommodations, thereby assisting the committee in completing its arrangements.

The spring meeting at Cleveland, Ohio, of the American Society of Mechanical Engineers, previously announced for the first week in June, has been changed to May 28 to 31. There are many resident engineers in Cleveland, and they are working to make this convention one of the best in the history of the organization. A complete statement will soon be issued of the papers to be discussed at the professional sessions.

At the twenty-fourth annual convention of the American Boiler Manufacturers' Association, the secretary of the Supplymen's Association was authorized to publish a list of "Boiler Manufacturers in the United States and Canada," which will comprise 100 names verified through mercantile agencies and by direct correspondence. The list will be of interest to manufacturers of tools used in boiler shops, material men, mechanical engineers and boiler buyers. It is arranged with a column in which the credit rating and financial responsibility can be inserted, and may be obtained for $5 by applying to F. B. Slocum, secretary Supplymen's Association, West and Calyer Sts., Brooklyn, N. Y.

Thirty-nine civil-engineering students of the Massachusetts Institute of Technology, who recently visited New York under the direction of Prof. Spofford, were the guests of the Brooklyn Engineers Club on the evening of Apr. 3. An informal talk on "Some European Power Plants" was given the students by George A. Orrok, of the New York Edison Co. He stated that while our power plants may not be the equal of those abroad, in the matter of economy of operation and coal consumption, the plants of the United States are run just as economically. Speaking of the prices paid for the soft coal used in the large power stations, Mr. Orrok said the cost of the fuel in Paris was about $3.60 per ton; in Newcastle from $1.75 to $2.25 per ton, and in London $2.50 per ton. He said the use of hard or anthracite coal in the power stations of the United States had ceased altogether, owing to the prohibitive cost of the fuel.

OBITUARY

Antonio Pacinotti, professor of technological physics at the University of Pisa (Italy) and the original inventor of the multi-segmental commutator, distributed winding and toothed armature core which are fundamental features of all modern direct-current dynamos, died on Mar. 24.

He was born in Pisa on June 17, 1841, and was therefore nearly 71 years old when he died. At an early age he studied what was then known of electricity and magnetism, and in 1860 invented and built the ring-armature direct-current dynamo with a distributed winding and commutator which was independently invented 10 years later by Gramme. The machine did not attract much attention at the time because its future importance was not realized. When he exhibited a model of his invention at the Vienna exposition in 1873, however, recognition of its merit was instantaneous. The Gramme machine invented in 1870 was also exhibited there and as it had been heralded and discussed widely during the preceding three years the scientific and engineering world was in a more appreciative and receptive mental state than when Pacinotti's little machine was built 13 years before.

Antonio Pacinotti

Pacinotti's leanings were in the direction of research and scientific development rather than practical exploitation, and this accounts for his allowing his splendid achievement to lie almost unknown for so many years while he applied himself to college work and study.

In 1862 he was appointed assistant professor of astronomy at Florence and his work there prevented his carrying out experimental work on a larger scale, which he had planned to do. In 1864 he was made professor of applied physics at Bologna and in 1873 received the same chair at Cagliara.

During the past 30 years, in recognition of Pacinotti's achievements and attainments, scientific bodies and engineering societies and congresses throughout the world bestowed upon him many honors, all of which were received with sincere appreciation and the unaffected modesty which endeared him to all who enjoyed the privilege of personal acquaintanceship with him.

We are indebted to the *Electrical World* for the use of the accompanying portrait and autograph.

PERSONAL

Ray Palmer, a consulting engineer of Chicago, Ill., has been appointed city electrician of Chicago, succeeding William Carroll, who recently resigned. Mr. Palmer is an associate member of the Institute of Electrical Engineers.

Aldis E. Hibner, power engineer of the Livingston Niagara Power Co., Avon, N. Y., has resigned to accept the position of electrical commercial manager of the Empire Gas & Electric Co., of Auburn, N. Y.

F. R. Fortune has been appointed to the newly created position of general sales manager of the Cooper Hewitt Electric Co. Burford Britton succeeds him as district sales manager. The headquarters of both officials will be in the Westinghouse Building, Pittsburg.

J. W. Fraser, assistant chief engineer for the Southern Power Co., and to whom much credit for the present very successful operation of the mammoth generating and transmission system of that company is due, has resigned his position in order to take charge of the building of a complete hydro-electric power plant and transmission system in Australia for the British Westinghouse Electric & Manufacturing Co. The Australian plant will have a capacity of about 100,000 kw. when completed. The first transmission line will be 64 miles long. Mr. Fraser has been with the Southern Power Co. for the past seven years and he is considered to be one of the foremost electrical engineers of the country in the realm of hydro-electric and high-tension plant construction and operation.

Moments with the Ad. Editor

MR. SAMUEL G. MARTIN, chief engineer of the Uxbridge Worsted Company, sends us a copy of POWER for November, 1890, with these remarks:

"Since our friend the advertising editor is so, shall I say, persistent in asking for criticism of the Selling Section of POWER, I will try to soothe his feelings.

"Enclosed are two copies of POWER—one 22 years old and one of current issue. They show the difference plainly enough and the improvement.

"A reader of POWER since 1890, I congratulate you sincerely on the Selling Section."

Thank you, Mr. Martin.

We can think of no more graphical way of showing the improvement in technical advertising, and especially in POWER'S advertising, than by reproducing an advertising page of the old days and asking you to compare it with the Selling Section of this issue.

The old ads. are fine examples of what handed trade and technical paper advertising a black eye.

They are mere "cards"—they say nothing and were never changed. They are sedate old tombstones, that's all.

The man who could get the most fancy stunts into the design of his type was the best advertiser.

They pulled some business only because there was nothing better—nothing conspicuously different.

The "general" advertiser, who was spending much more money than the trade paper advertiser, woke up first.

He got real meat into his space and attractiveness into his layout.

But the technical advertiser continued in the old rut long enough to have the outside world ridiculing his efforts.

As a matter of fact, the technical paper publisher was the first to get busy and induce his advertisers to put live "reason why" copy into their ads. It was done as a matter of self-protection—done to make the ads. actually pay.

Now it is no exaggeration to say that some of the best advertising in the country is found in those technical papers which insist that the advertising pages shall be interesting, informative and instructive.

Hence you will find today—in this very issue—that POWER advertising is worth reading.

Things 22 years ago were done differently; power was generated and transmitted differently. You buy and read POWER to know how things are done *now*—this week.

If you want to know *what* they are *done with*, read the ads.

NEW EQUIPMENT

ATLANTIC COAST STATES

The Geo. H. Ward Manufacturing Co., Gilbertville, Mass., will erect a new boiler house in the rear of its electric plant.

Wakefield, Mass., has voted favorably on the appropriation of $15,000 for the improvement of the municipal electric-light plant. Albert B. Morton is superintendent of plant.

The city council, Camden, N. Y., is considering the appropriation of $300,000 for the construction of a municipal electric-light plant.

The citizens of Glen Park, N. Y., have voted to install an electric street-lighting system.

The breaking of a dam in the Oswego River at Oswego, N. Y., wrecked the power plant, causing damage of $40,000.

The borough council, Coatesville, Penn., contemplates the installation of an electric-light plant.

Bechtelsville, Penn., contemplates the installation of an electric-light plant.

The Pennsylvania Light, Heat & Power Co., of the North Side, Pittsburg, Penn., has made arrangements for an addition to its plant which will include additional boiler capacity and the installation of stokers for the entire battery of boilers.

The Scoffield Engineering Co., Arcade Building, Philadelphia, Penn., has been retained by the Harwood Electric Co., to prepare plans for the extension of its power house at Harwood, Penn., and the reconstruction of its substation at Hazleton, Penn.

The Lily Coal & Coke Co., West Brownsville, Penn., contemplates installing electrical equipment in its plant at a cost of $300,000. Thomas Lily, Brownsville, Penn., is interested.

Culpepper, Va., will soon receive bids for the construction of a filtration plant to cost about $7000.

Gordonsville, Va., has voted bonds for $10,000 for improving the water-works system.

The Stuart Water Co., Stuart, Va., has been incorporated to construct a water-works system. W. H. Wimblish is president.

SOUTHERN STATES

The J. B. McCrary Co., Empire Building, Atlanta, Ga., is preparing plans for the installation of an electric-light plant at Spencer, N. C.

A. V. Smith is promoting the establishment of an electric-light plant and water-works system at Lockport, La.

The Winnfield Ice & Cold Storage Co., Winnfield, La., contemplates the installation of a new generator and engine in its recently purchased plant.

The Booneville Light & Power Co. has been incorporated to build an electric-light plant at Booneville, Ky. The incorporators are H. C. Combs, T. C. Fuller and C. B. Moore.

CENTRAL STATES

Bids will be received by Charles E. Thorne, director of the Ohio agricultural experiment station, Wooster, Ohio, until Apr. 25, for the construction of an addition to the power plant.

The plant at Fifth and Mulberry Sts., Evansville, Ind., of the Evansville Public Service Co., will be enlarged to provide room for the installation of additional equipment.

The Sullivan County Water Co., Sullivan, Ind., has been incorporated to construct a water-works system. The incorporators are E. M. Kerlin, J. L. Ebner and T. Morrisey Vincennes, Ind.

The installation of an electric-light plant in the Illinois Theater, Urbana, Ill., is contemplated.

The Villa Grove Electric Co. will soon start work on the reconstruction of its power plant which was recently destroyed by fire. An artificial ice plant will also be installed. A. G. Clements is engineer of power station.

The Galesburg Ry. & Light Co., contemplates the installation of an electric-light plant at Abingdon, Ill. H. E. Chubbuck, Peoria, Ill., is general manager.

WEST OF THE MISSISSIPPI

F. B. Parsons has been granted a franchise to establish an electric-light plant at Emmetsburg, Iowa.

The city council, of Albert Lea, Minn., has been petitioned to take steps toward the construction of a municipal electric-light plant.

Harmon Becker has been granted a franchise to construct and operate an electric-light plant at Foley, Minn.

Worthington, Minn., contemplates the installation of an additional generating unit in the municipal electric-light plant. W. H. Buchan is superintendent of plant.

Wellsville, Kan., is considering plans for the installation of an electric-light plant.

Williamsburg, Kan., is considering the installation of an electric-light plant. Estimated cost, $3000.

The Central Coal & Coke Co., Keith Building, Kansas City, Mo., is receiving bids for 1400-hp. boilers to be used in supplying energy to operate its various mines around Rock Springs, Wyo. H. Campbell, Kansas City, is general manager.

The City Water & Light Co., Anson, Tex., will construct an electric-light plant at a cost of $10,000. J. W. Skinner is engineer in charge.

Bigheart, Okla., contemplates the installation of a water-works system. Estimated cost, $25,000.

The Benham Engineering Co., American National Bank Bldg., Oklahoma City, Okla., has been retained to prepare plans for the installation of a water-works system at Perkins, Okla. Estimated cost, $25,000.

The Colorado & Southern Ry. Co., Denver, Colo., is receiving bids for three 500-hp. and four 350-hp. units of water-tube boilers, equipped with chain grate stokers and superheaters, mechanical draft fan, together with smoke breeching and stack, to be installed at Denver. W. C. Weldon, Cooper Building, Denver, is purchasing agent.

The Seattle Engineering School, Inc., Seattle, Wash., has decided to install steam and gas engines, boilers, pumps, dynamos and other equipment in its new school building now being constructed at Third Ave. and Pine St.

The Arlington Club, Portland, Ore., is contemplating the installation of a vacuum cleaner, two sweeper machines, motor driven, a.c. current, 220 volts, 60 cycles.

Long Beach, Calif., contemplates the construction of an electric pumping plant for the water department. E. P. Dewey is city engineer.

Roberts & Denicke, San Francisco, Calif., are preparing plans for the installation of a water-works system at Modesto, Calif.

BUSINESS ITEMS

Walter G. Ruggles Co., Boston, Mass., has opened a branch office at 136 Liberty St., New York. The new office is in charge of Wm. J. McAuslin.

The Ashton Valve Co., 271 Franklin St., Boston, Mass., about May 1, will move its Chicago office from 166 West Lake St., to larger quarters at 174 North Market St.

The Kennedy Valve Manufacturing Co., Elmira, N. Y., secured the order from the new Hotel McAlpin, New York, for valves for high-pressure steam, plumbing and hydraulic elevator services.

The Magnolia Metal Co., 112 Bank St., New York, has just issued a new booklet containing testimonials and tests describing the value and uses of Magnolia anti-friction metal and giving full directions for pouring the metal. Copies are sent on request.

Owing to the constantly increasing demand for Durabla power-plant products, the Durabla Manufacturing Co., 114 Liberty St., New York, has had to move into larger quarters and after May 1 will occupy the entire front of the second story of the building it is now in. The sales of Durabla gage glasses during the past year have been treble the sales during the previous year.

ENGINEERS WANTED

Under this head are published, without charge, advertisements of actual vacancies in power plants for operating engineers and assistant engineers. For the guidance of applicants for advertised positions, the advertisements must contain particulars to show the class of service demanded and the wages paid. Employers who desire to advertise under this head are requested to write for a blank form of application.

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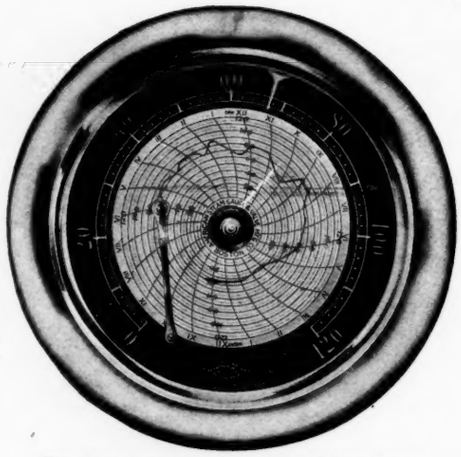

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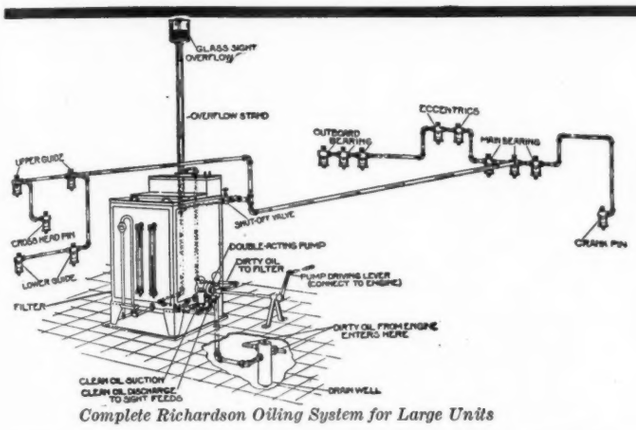

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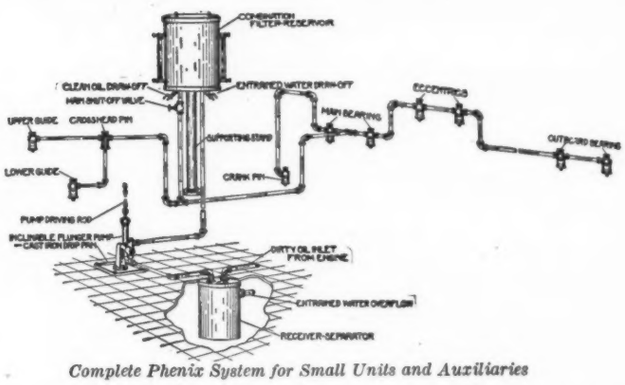

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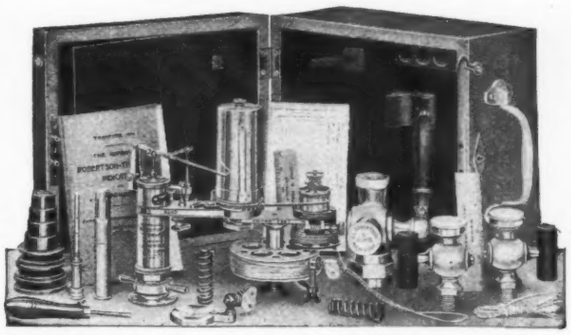

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